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Cook

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(54) **PNEUMATIC SOCK EXERCISE DEVICE**

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(22) Filed: **Oct. 30, 2014**

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A61F 5/41 (2006.01)
A63B 21/008 (2006.01)
A63B 21/00 (2006.01)

(52) **U.S. Cl.**
CPC ***A63B 21/0087*** (2013.01); ***A63B 21/0012*** (2013.01)

(58) **Field of Classification Search**
CPC A61F 5/41; A61F 5/411; A61F 5/412; A61F 5/417
USPC 482/44, 111; 600/38
See application file for complete search history.

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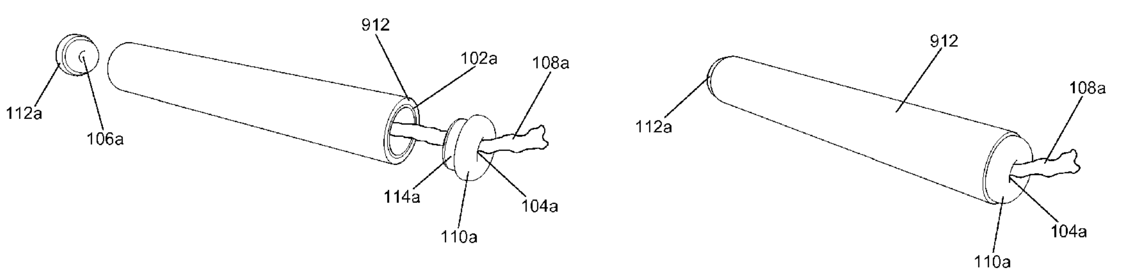
(57) **ABSTRACT**

Embodiments relate to a pneumatic sock exercise device utilizing pneumatic resistance transmitted to a user by a pneumatic sock capable of slidable movement within a pneumatic conduit or a pneumatic conduit structure configured to be removably interfaced with a source of airflow. The pneumatic conduit may include hollow cylinders, pipes, tubes, hoses, or ducts. The pneumatic sock is a tubular structure made of a flexible material that includes various aspects and features. When an embodiment is interfaced with the source of airflow, the pneumatic sock enables airflow within the pneumatic conduit or pneumatic conduit structure to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise. Some embodiments may include an extension means and/or an anti-friction means to extend the range of movement of the pneumatic sock. The same or other embodiments may include a housing including a pneumatic conduit structure. A cushion of a resilient material may be included in an embodiment.

20 Claims, 18 Drawing Sheets



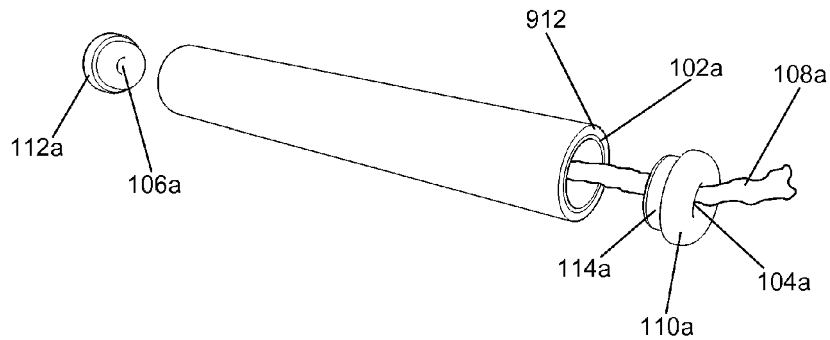


FIG. 1A

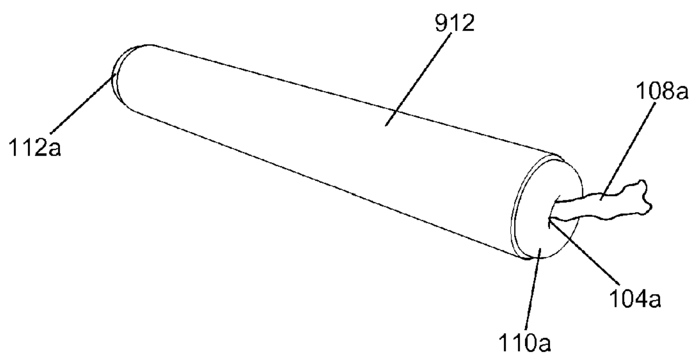


FIG. 1B

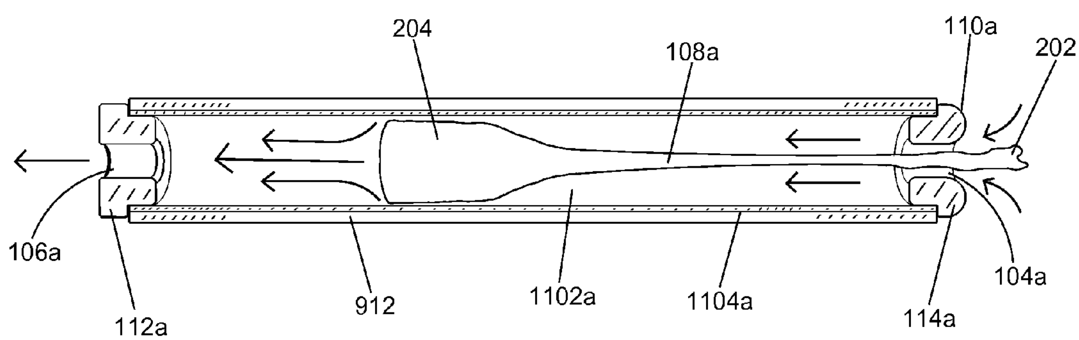


FIG. 1C

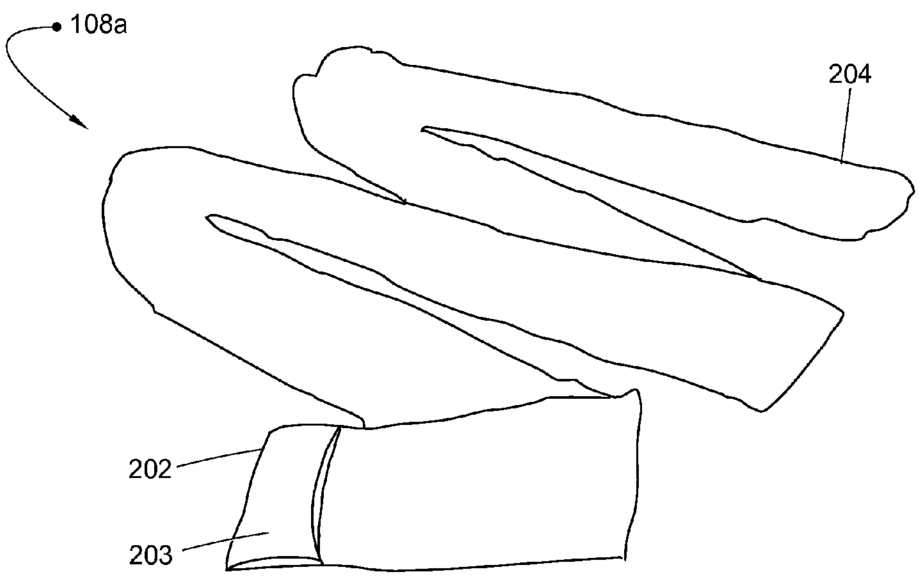


FIG. 2A

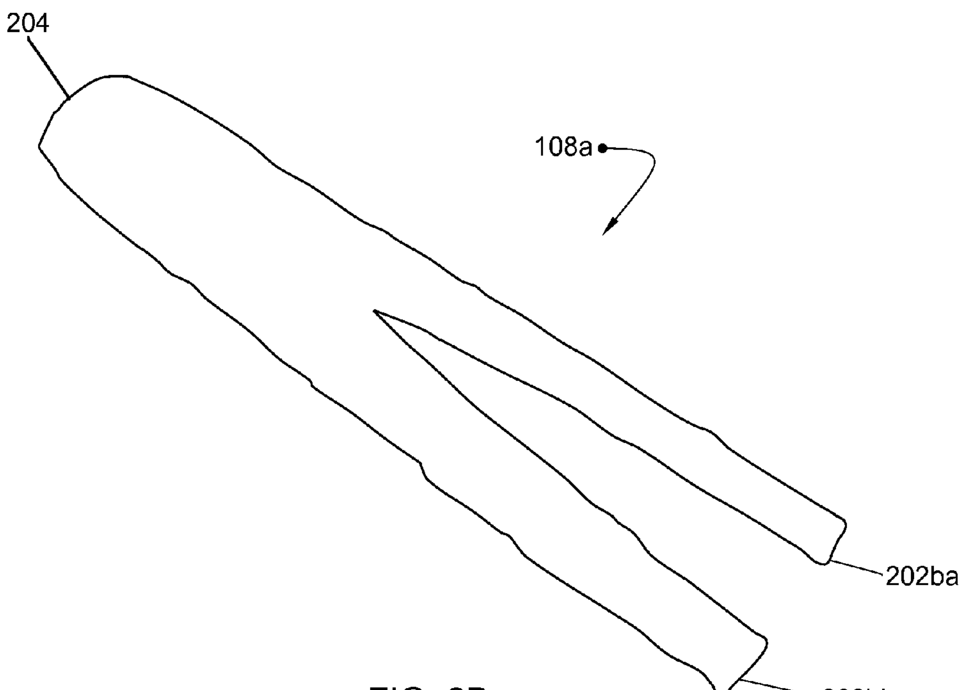


FIG. 2B

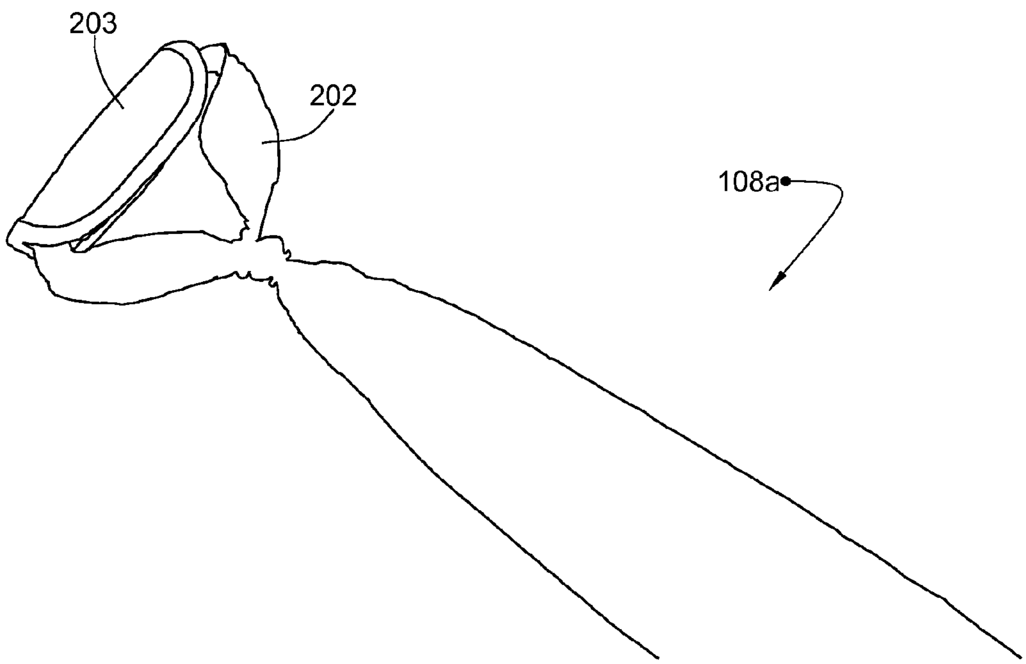


FIG. 3A

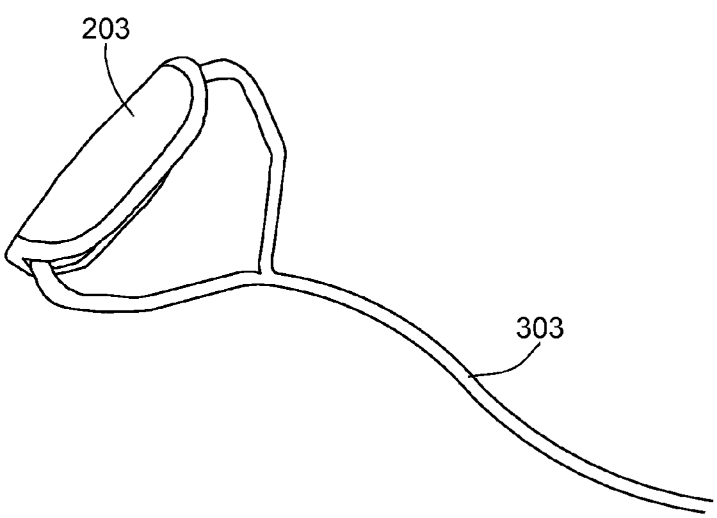


FIG. 3B

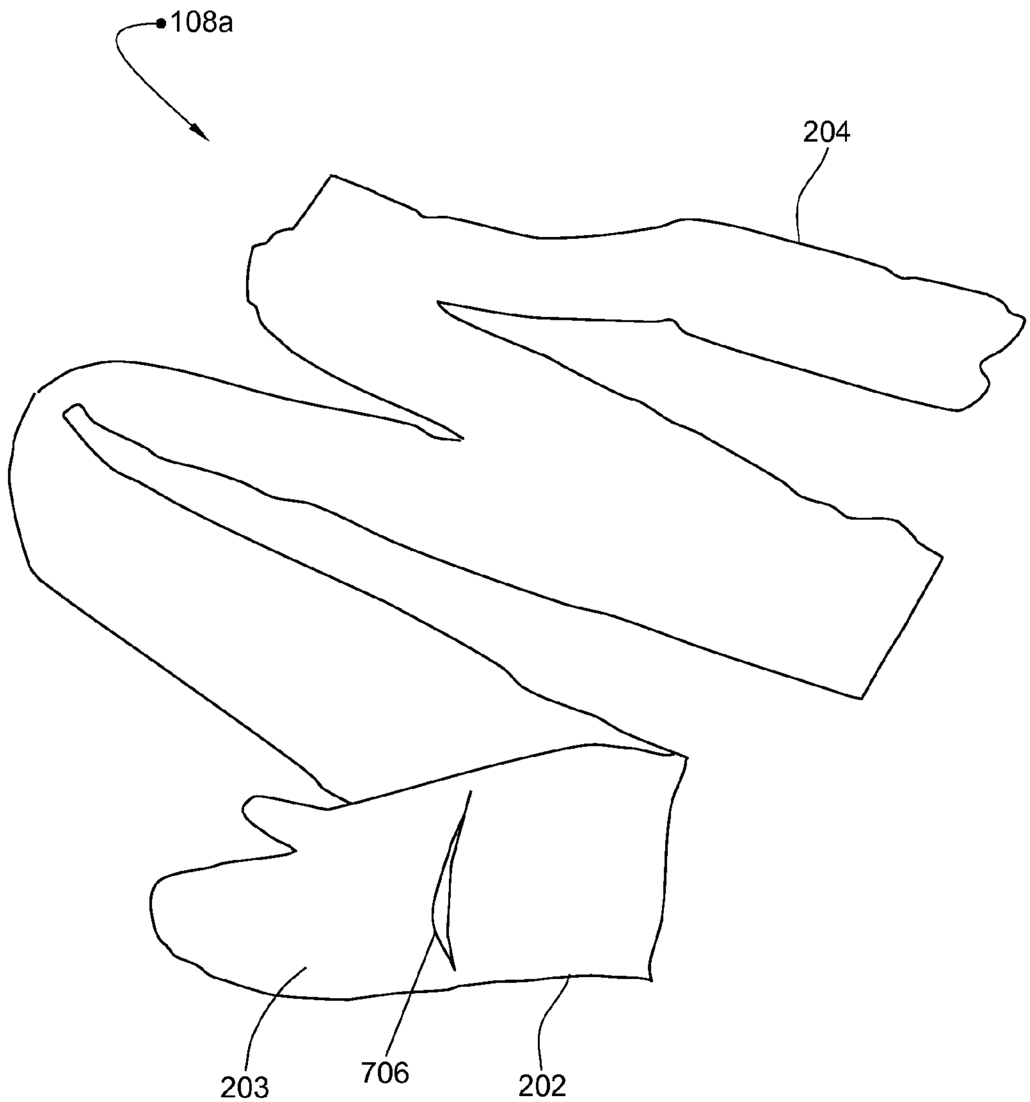


FIG. 4

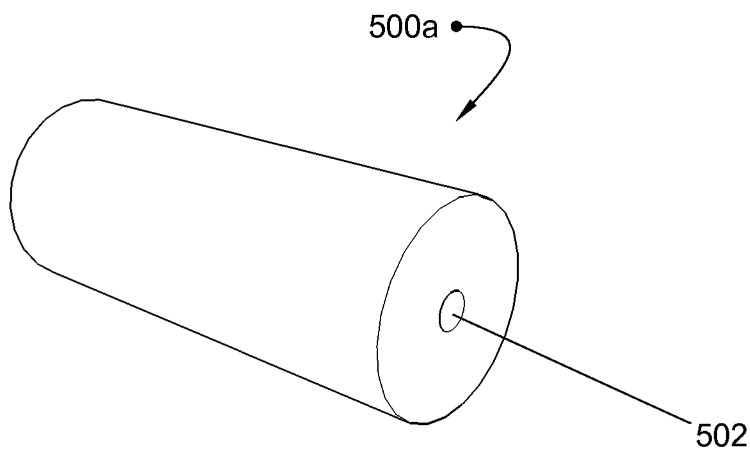


FIG. 5A

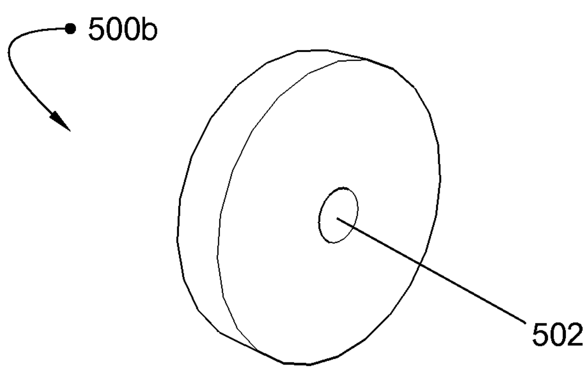


FIG. 5B

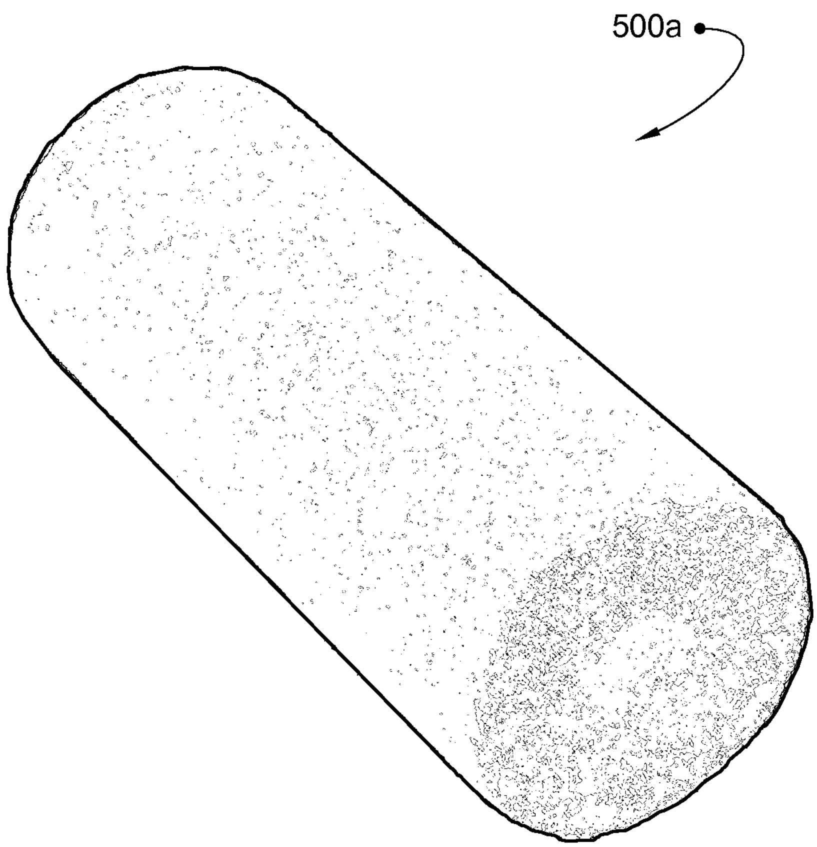


FIG. 6

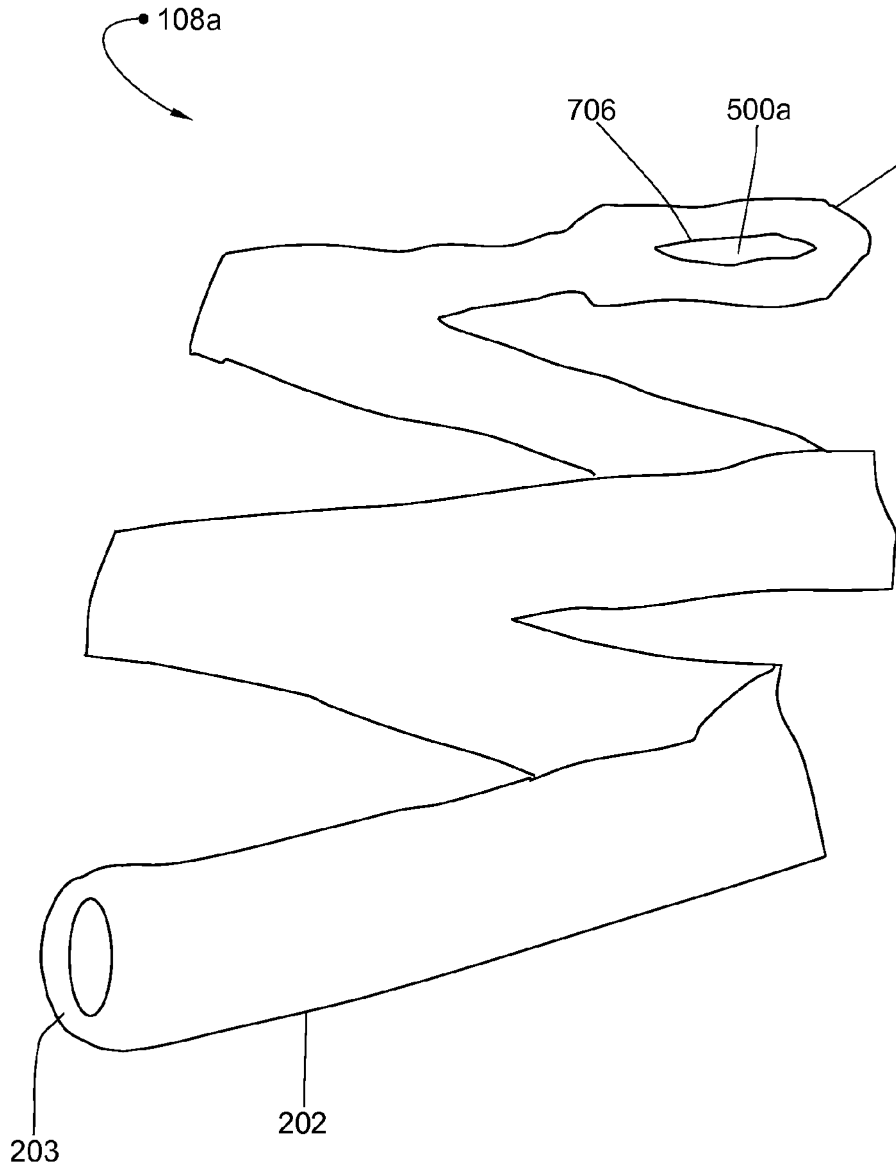


FIG. 7

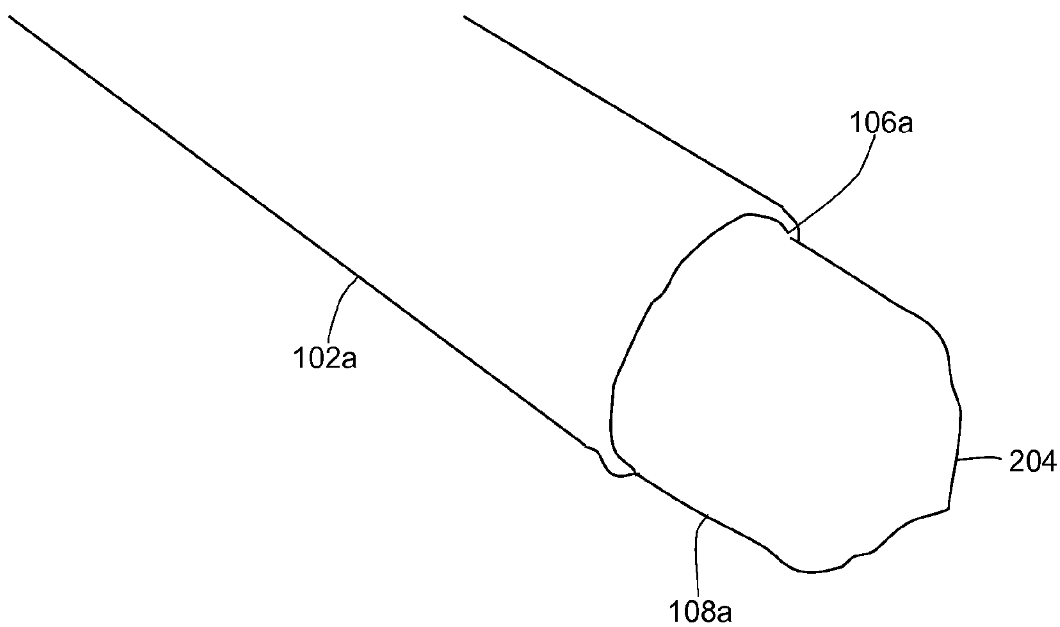


FIG. 8

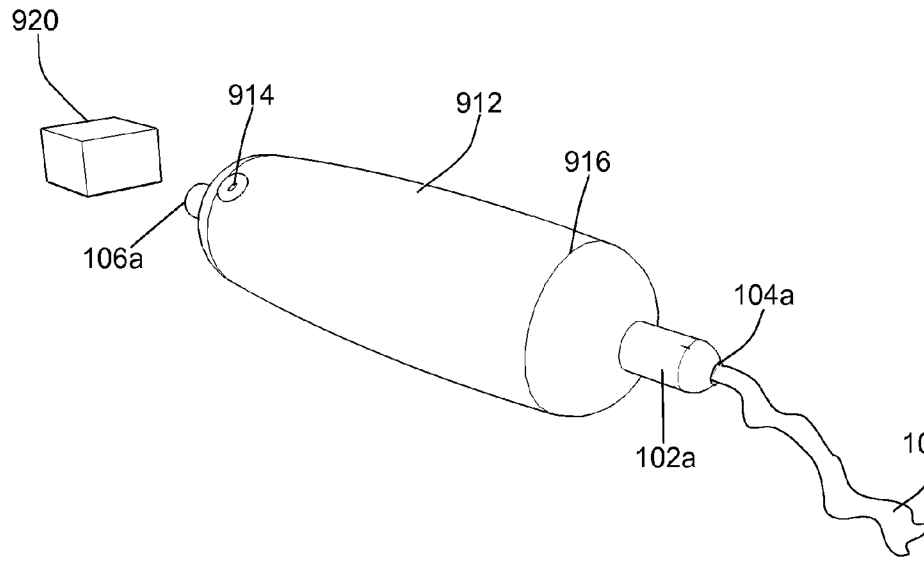

920
914
912
916
106a
104a
102a
108a

FIG. 9A

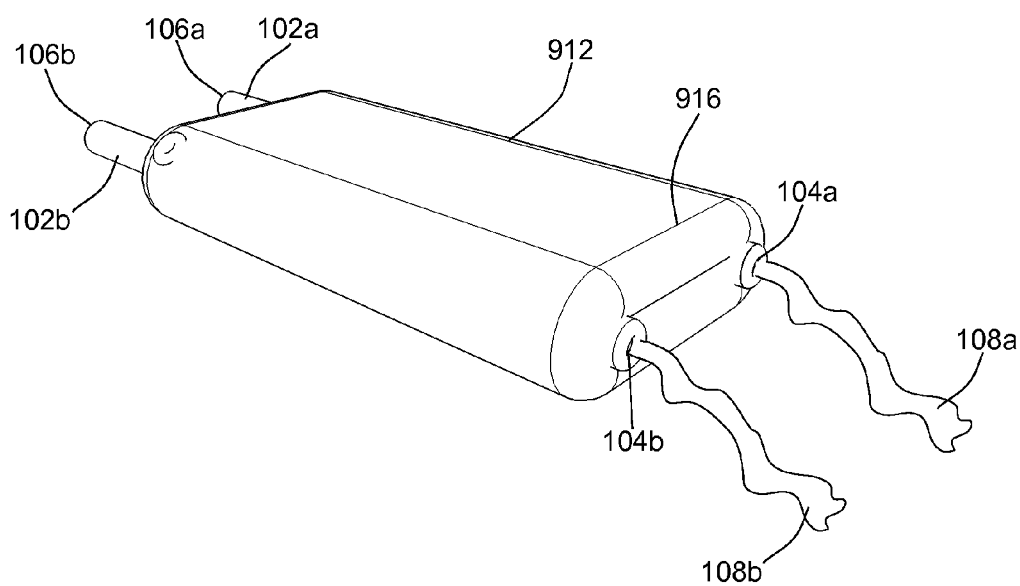

106a
102a
106b
912
916
102b
104a
108a
104b
108b

FIG. 9B

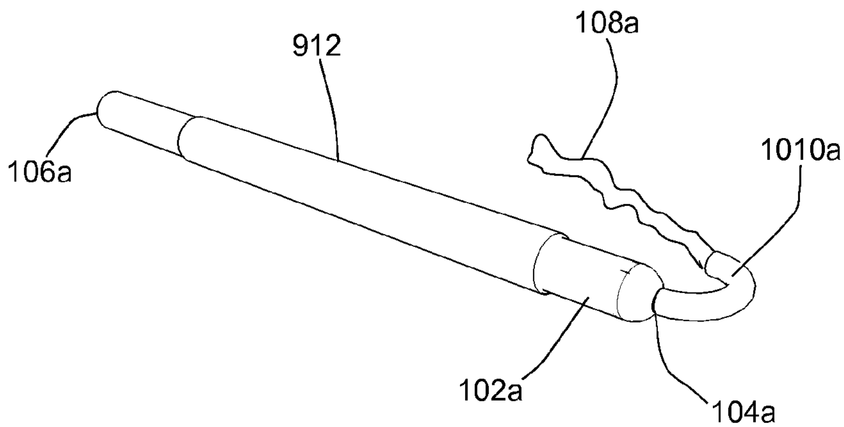


FIG. 10A

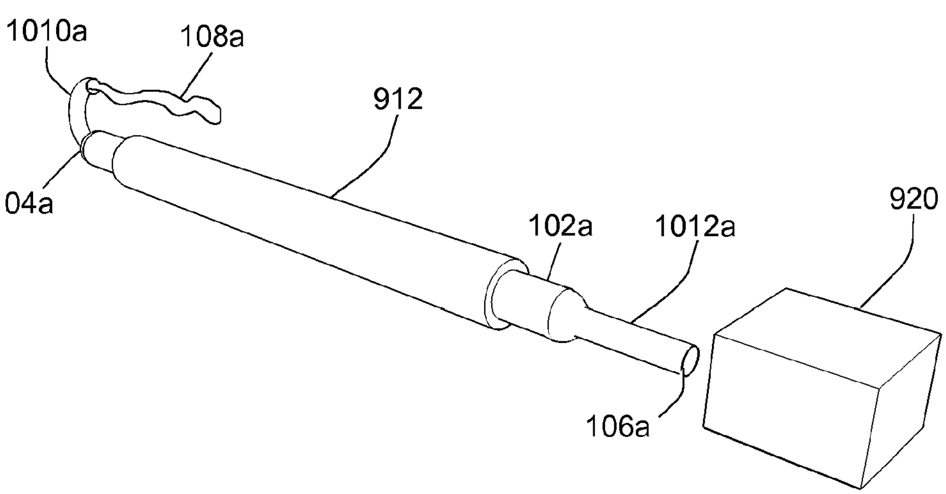


FIG. 10B

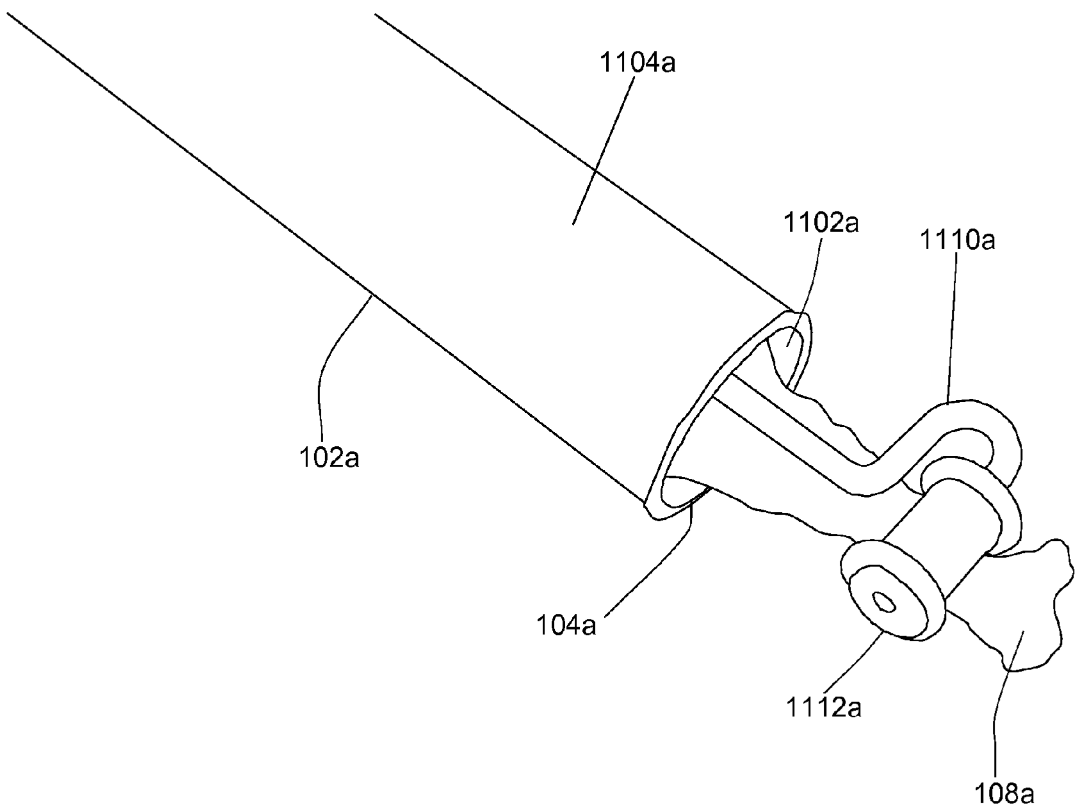


FIG. 11

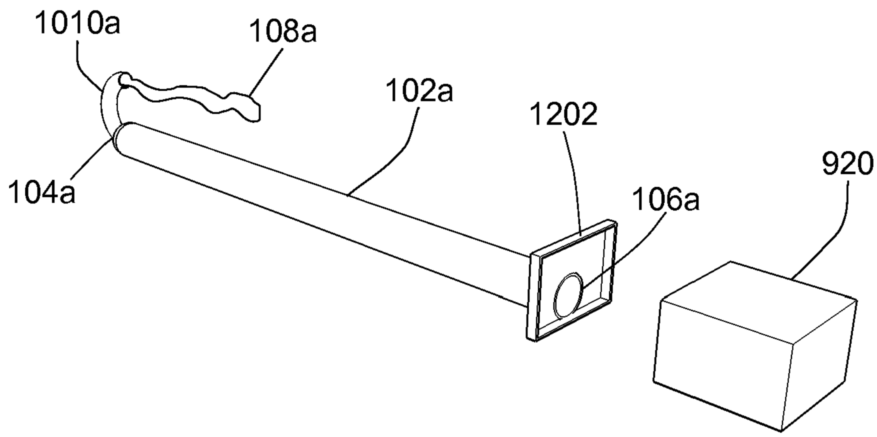


FIG. 12A

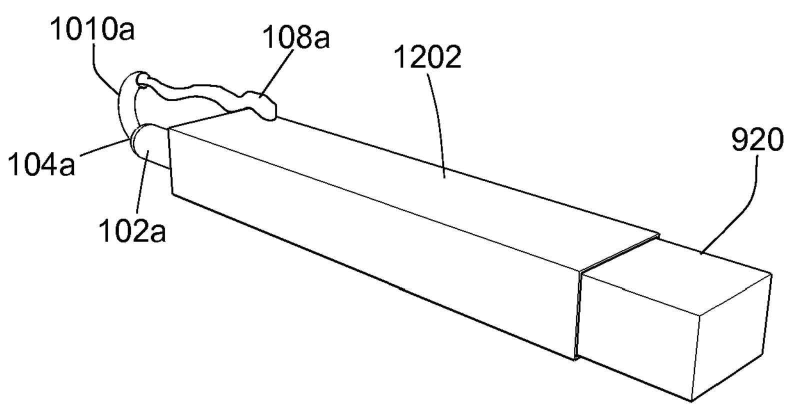


FIG. 12B

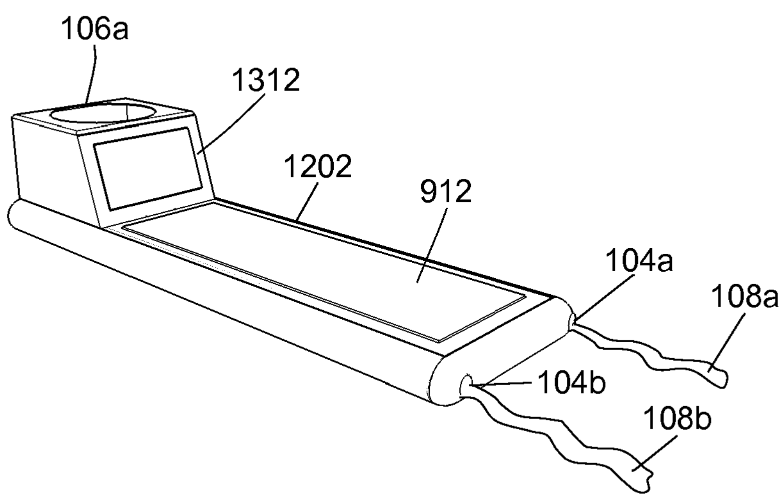


FIG. 13

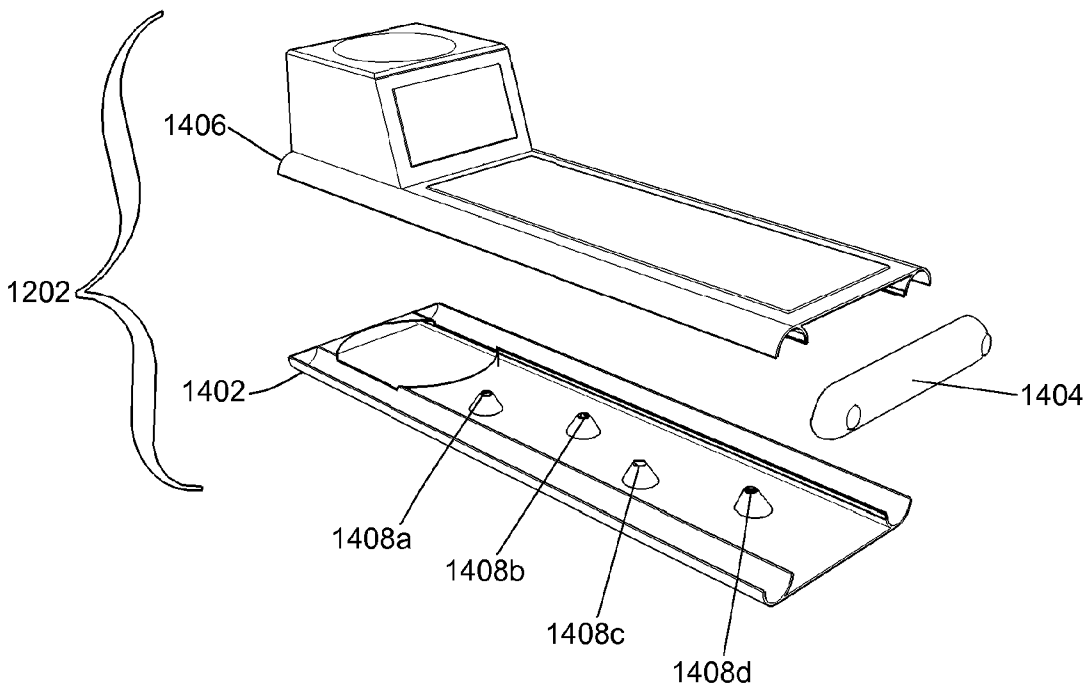


FIG. 14

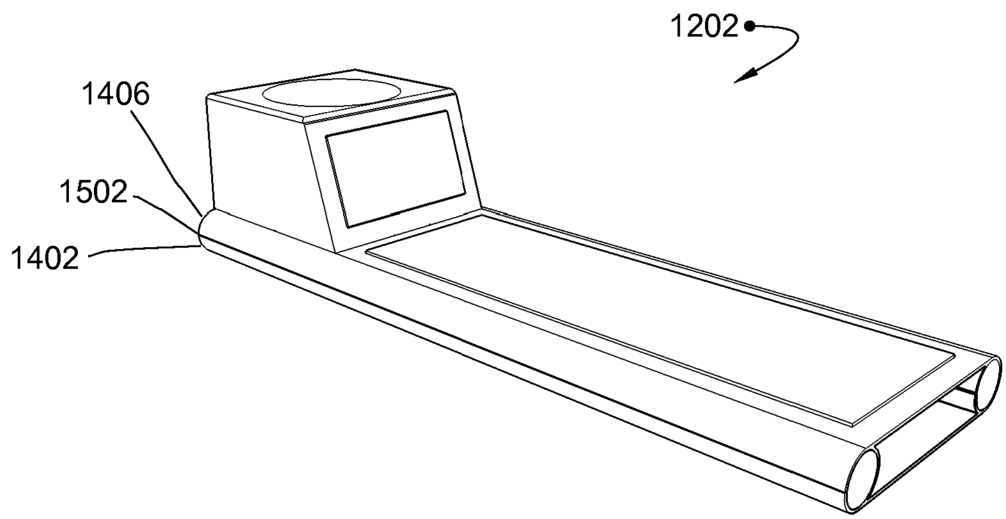


FIG. 15

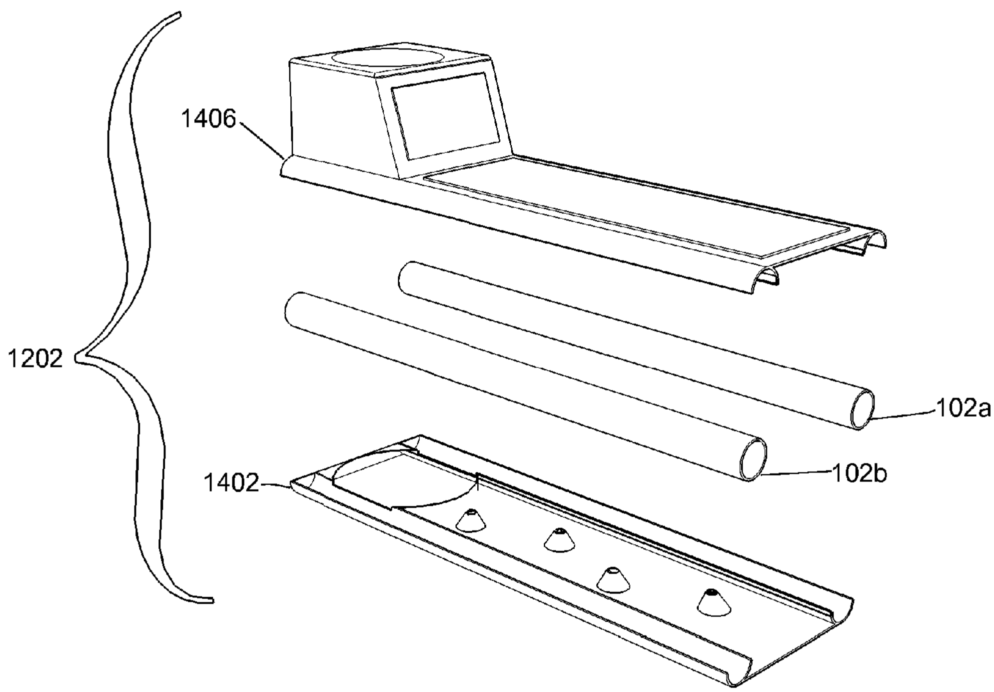


FIG. 16

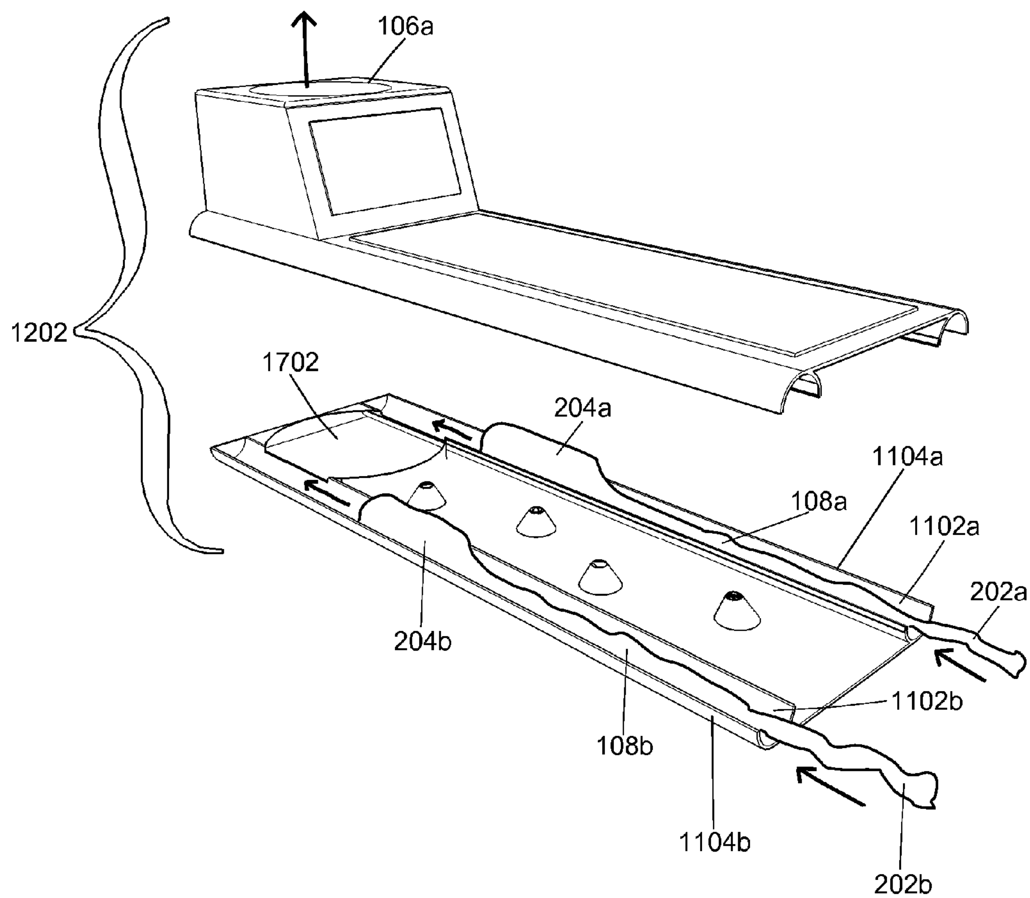

106a
1202
1702
204a
1104a
108a
1102a
202a
204b
1102b
108b
1104b
202b

FIG. 17

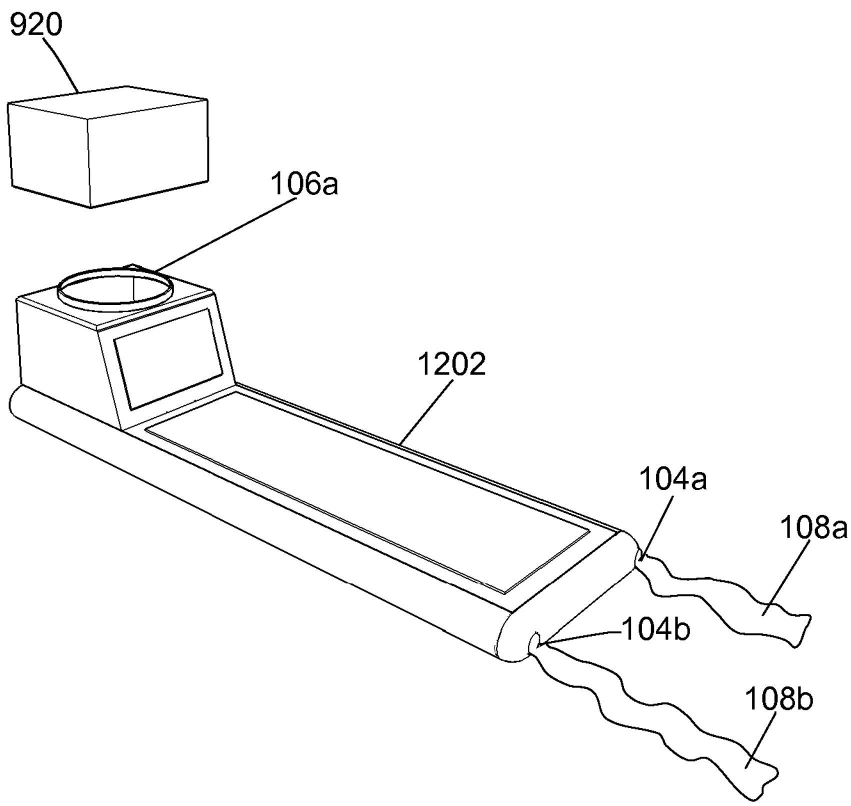


FIG. 18

PNEUMATIC SOCK EXERCISE DEVICE

BACKGROUND

The present invention relates to pneumatic exercise devices. One of the advantages of employing pneumatic resistance in an exercise device is to reduce acceleration forces that occur when a user increases the speed of exercise movements. Acceleration forces make it difficult for a user to train at a consistent level of resistance unless constant speed of movement is maintained; furthermore, acceleration forces may contribute to user injuries during exercise. In theory, pneumatic exercise equipment would have no acceleration forces produced due to increasing speed of user movement, if the weight of the moving parts were zero. However, in practical application pneumatic exercise equipment has moving parts with weight that can potentially generate acceleration forces during exercise. These moving parts traditionally include a pressure opposing structure such as a piston rod assembly, a user interface such as a handle, and any additional mechanical linkage components such as a cable, that may be necessary to connect a pressure opposing structure and a user interface. Furthermore, exercise devices employing pneumatic resistance are often large and expensive, with complicated moving parts to transmit pneumatic resistance to the user.

SUMMARY

The present invention is a contemporary design of a pneumatic sock exercise device that decreases acceleration forces when a user increases the speed of exercise movements and has additional advantages. Embodiments of this pneumatic sock exercise device combine the benefits of pneumatic resistance in a device that is lightweight, compact, and affordable for the typical exercise consumer. In addition, a pneumatic sock exercise device is less complicated and less intimidating than traditional designs having complicated moving parts and imposing frames. Consequently, the pneumatic sock exercise device of the present invention is a contemporary and practical design that will facilitate greater exercise participation.

Disclosed herein is a pneumatic sock exercise device, the pneumatic sock exercise device comprising a pneumatic conduit having a primary opening permitting inflow of air and a secondary opening permitting outflow of air, configured to be removably interfaced with a source of airflow, and a pneumatic sock comprising a tubular structure made of a flexible material having a proximal end and a distal end. The distal end of the pneumatic sock is slidably coupled within the pneumatic conduit and the proximal end of the pneumatic sock extends through the primary opening of the pneumatic conduit. During exercise, the distal end of the pneumatic sock shuttles along a path adjacent to the interior wall within the pneumatic conduit when the proximal end of the pneumatic sock is moved by a user on a path towards and away from the primary opening of the pneumatic conduit, whereby the pneumatic sock enables airflow within the pneumatic conduit to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise. Throughout this application the inventor has elected to use the term "couple" as the slidable engagement (shuttling) of the pneumatic sock within the pneumatic conduit; however, the elements need not be physically joined or otherwise physically connected to be considered "coupled" for purposes of this written description and the claims.

In another aspect, the pneumatic sock exercise device comprises a pneumatic conduit having a primary opening permitting inflow of air and a secondary opening permitting outflow of air, configured to be removably interfaced with a source of airflow, a cushion made of a resilient material configured to substantially enclose the exterior walls of the pneumatic conduit, and a pneumatic sock comprising a tubular structure made of a flexible material having a proximal end and a distal end. The distal end of the pneumatic sock is slidably coupled within the pneumatic conduit and the proximal end of the pneumatic sock extends through the primary opening of the pneumatic conduit. During exercise, the distal end of the pneumatic sock shuttles along a path adjacent to the interior wall within the pneumatic conduit when the proximal end of the pneumatic sock is moved by a user on a path towards and away from the primary opening of the pneumatic conduit, whereby the pneumatic sock enables airflow within the pneumatic conduit to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise.

In an additional aspect, the pneumatic sock exercise device comprises a housing comprising a pneumatic conduit structure having at least one primary opening permitting inflow of air and at least one secondary opening permitting outflow of air, configured to be removably interfaced with a source of airflow, and at least one pneumatic sock comprising a tubular structure made of a flexible material having a proximal end and a distal end. The distal end of at least one pneumatic sock is slidably coupled within the pneumatic conduit structure and the proximal end of at least one pneumatic sock extends through a primary opening of the pneumatic conduit structure. During exercise, the distal end of at least one pneumatic sock shuttles along a path adjacent to the interior walls within the pneumatic conduit structure when the proximal end of at least one pneumatic sock is moved by a user on a path towards and away from at least one primary opening of the pneumatic conduit structure, whereby at least one pneumatic sock enables airflow within the pneumatic conduit structure to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise.

For purposes of contributing to an understanding of the pneumatic sock exercise device, certain aspects and advantages have been briefly summarized herein. Not necessarily all aspects and advantages may be achieved in accordance with any particular embodiment of the pneumatic sock exercise device. All embodiments are intended to be within the scope of the pneumatic sock exercise device. These and other embodiments will become readily apparent to those skilled in the art from the following detailed description having reference to the attached figures, the pneumatic sock exercise device not being limited to any particular embodiments disclosed.

BRIEF DESCRIPTION OF DRAWINGS

The pneumatic sock exercise device will now be described with reference to drawings of embodiments. The drawings are intended to illustrate various embodiments and not to limit the scope of the pneumatic sock exercise device.

FIG. **1**A depicts a perspective view of a pneumatic sock exercise device in an embodiment.

FIG. **1**B depicts a perspective view of a pneumatic sock exercise device in an embodiment.

FIG. **1**C depicts a cross-section view of a pneumatic sock exercise device in an embodiment.

FIG. **2**A depicts a perspective view of a pneumatic sock in an embodiment.

FIG. **2**B depicts a perspective view of a pneumatic sock in an embodiment.

FIG. 3A depicts a perspective view of a user interface in an embodiment.

FIG. 3B depicts a perspective view of a user interface in an embodiment.

FIG. 4 depicts a perspective view of a pneumatic sock in an embodiment.

FIG. 5A depicts a perspective view of a cylinder-shaped member in an embodiment.

FIG. 5B depicts a perspective view of a disc-shaped member in an embodiment.

FIG. 6 depicts a perspective view of a cylinder-shaped member in an embodiment.

FIG. 7 depicts a perspective view of a pneumatic sock in an embodiment.

FIG. 8 depicts a partial perspective view of a pneumatic sock exercise device in an embodiment.

FIG. 9A depicts a perspective view of a pneumatic sock exercise device and an air evacuation source in an embodiment.

FIG. 9B depicts a perspective view of a pneumatic sock exercise device in an embodiment.

FIG. 10A depicts a perspective view of a pneumatic sock exercise device including an extension tube in an embodiment.

FIG. 10B depicts a perspective view of a pneumatic sock exercise device including an extension tube and an air evacuation source in an embodiment

FIG. 11 depicts a partial perspective view of a pneumatic sock exercise device including an extension arm and a pulley in an embodiment.

FIG. 12A depicts a perspective view of a pneumatic sock exercise device and an air evacuation source in an embodiment.

FIG. 12B depicts a perspective view of a pneumatic sock exercise device and an air evacuation source in an embodiment.

FIG. 13 depicts a perspective view of a pneumatic sock exercise device in an embodiment.

FIG. 14 depicts an exploded perspective view of a housing and pneumatic conduit structure in an embodiment.

FIG. 15 depicts a perspective view of a housing and pneumatic conduit structure with the front portion removed in an embodiment.

FIG. 16 depicts an exploded perspective view of a housing and pneumatic conduit structure with the front portion removed with additional pneumatic conduits in an embodiment.

FIG. 17 depicts an exploded perspective view of a pneumatic sock exercise device including arrows to indicate direction of airflow in an embodiment.

FIG. 18 depicts a perspective view of a pneumatic sock exercise device and an air evacuation source in an embodiment.

DETAILED DESCRIPTION OF EMBODIMENTS

The pneumatic sock exercise device can take a variety of forms and can be used in a variety of manners as will be apparent from the description of the following embodiments. Not all of the aspects and features of the pneumatic sock exercise device need to be employed in a single embodiment. Some of the embodiments described herein include a combination of various aspects and features described in the summary, and others will include additional aspects and features. Embodiments may be adapted to various exercises and methods of exercise as would be contemplated by one skilled therein.

Embodiments of a pneumatic sock exercise device utilize resistance provided by air or airflow in a confined pneumatic chamber, a pneumatic cylinder, a hollow cylinder or tube, a hollow pneumatic conduit, a plurality of pneumatic conduits, or a housing comprising pneumatic conduit structure, and transmitted to the user by a pneumatic sock comprising a tube or a plurality of tubular sock-like structures made of a flexible material such as fabric or mesh. It is preferred that embodiments are configured to be removably interfaced with a source of airflow comprising an air evacuation source, which may include an external conduit structure such as a hose. The source of airflow may comprise the air evacuation source as depicted in FIGS. **9**A, **10**B, **12**A, **12**B, and **18**.

FIGS. **1**A & **1**B depict a perspective view of a pneumatic sock exercise device in an embodiment comprising a pneumatic conduit **102***a* having a primary opening **104***a* permitting inflow of air and a secondary opening **106***a* permitting outflow of air and a pneumatic sock **108***a* comprising a tubular structure made of a flexible material. The secondary opening **106***a* may comprise a removable connector **112***a* or fitting configured to be removably interfaced with a source of airflow, such as a hose attachment to a vacuum for household use, by a sliding or push fit in an embodiment. The pneumatic sock **108***a*, extending through the primary opening **104***a*, is slidably coupled within the pneumatic conduit **102***a*. The primary opening **104***a*, comprising a rounded flange **110***a*, a removable bushing **114***a* comprising the rounded flange **110***a*, or a flared (e.g., trumpet shaped) opening, provides a range of substantially unrestricted movement to the pneumatic sock **108***a* extending through the primary opening **104***a* of the pneumatic conduit **102***a*, thereby providing an extension means and an anti-friction means in an embodiment. The removable bushing **114***a* comprising the rounded flange **110***a* and the removable connector **112***a* may be made from strong, lightweight, and inexpensive polymers, preferably having a low coefficient of friction, including but not limited to acetal, acrylic, acrylonitrile butadiene styrene, nylon, phenolics, polycarbonate, polyester, polyethylene, polypropylene, polyvinyl chloride, polyurethane, and other such materials by molding and/or machining or other manufacturing methods. For example, the removable bushing **114***a* comprising the rounded flange **110***a* and the removable connector **112***a* may be lathed from machinable plastic rod, such as acetal rod stock, preferably of about 5 inch diameter but other diameters may be used in an embodiment. The removable bushing **114***a* comprising the rounded flange **110***a* and the removable connector **112***a* are configured to be removably interfaced with the pneumatic conduit **102***a* by a sliding or push fit in an embodiment. The primary opening **104***a* may also include extension means or anti-friction means in addition to or in place of the removable bushing **114***a* and/or the rounded flange **110***a* such as a roller, wheel, pulley, pulley system, rolling-element bearing, plain bearing, flexure bearing, fluid bearing, or a lining or coating with a low coefficient of friction or combinations thereof to provide a range of substantially unrestricted movement to the proximal end of the pneumatic sock **108***a* in an embodiment. A cushion **912** comprising a resilient material such as foam, with or without a fabric covering such as vinyl, configured as a bolster or a pad to substantially enclose the pneumatic conduit **102***a* may be included in an embodiment, thereby providing cushioning for a user and providing cushioning between the pneumatic conduit **102***a* and the floor. The pneumatic conduit **102***a* including the cushion **912** may comprise a foam roller having a rigid, hollow, cylindrical core in an embodiment. The user is able to sit, step, stand, or recline on the cushion **912** enclosing the pneumatic conduit **102***a* in an embodiment, thereby employing the user's body weight to anchor an embodiment to the floor.

FIG. **1**C depicts a cross-section view of a pneumatic sock exercise device in an embodiment comprising the pneumatic conduit (as depicted in FIG. **1**A) having an interior wall **1102***a* and an exterior wall **1104***a*, the primary opening **104***a* permitting inflow of air, the secondary opening **106***a* permitting outflow of air, the pneumatic sock **108***a*, and arrows indicating direction of airflow during operation. The pneumatic sock **108***a* has a distal end **204** slidably coupled within the pneumatic conduit **102***a* and the pneumatic sock **108***a* has a proximal end **202** extending through the primary opening **104***a* of the pneumatic conduit **102***a*. When the secondary opening **106***a* is interfaced with a source of airflow, such as a hose attachment to a vacuum for household use, the distal end **204** of the pneumatic sock **108***a* is urged by and in the direction of airflow within the pneumatic conduit **102***a* as indicated by the arrows. As a user moves the proximal end **202** of the pneumatic sock **108***a* on a path towards and away from the primary opening **104***a* during exercise, the distal end **204** of the pneumatic sock **108***a* shuttles along a path adjacent to the interior wall **1102***a* within the pneumatic conduit **102***a*. Airflow within the pneumatic conduit **102***a*, urging the distal end **204** of the pneumatic sock **108***a* in the direction of the airflow, transmits pneumatic resistance to the user during exercise as the user moves the proximal end **202** of the pneumatic sock **108***a* on a path towards and away from the primary opening **104***a*. The cushion **912** comprising a resilient material may be configured to substantially enclose the exterior wall **1104***a* of the pneumatic conduit **102***a* (as depicted in FIG. **1**A) in an embodiment. For example, the cushion **912** may comprise a resilient material such as foam, preferably ranging from about ½ inch to about 1 inch in thickness, substantially enclosing and fastened to the exterior wall **1104***a* of the pneumatic conduit **102***a* with an adhesive or other fastening means in an embodiment.

The pneumatic sock **108***a* illustrated in FIGS. **1**A, **1**B & **1**C may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**. The pneumatic sock **108***a* is a tubular-shaped structure made of a flexible material having a proximal end and a distal end and may include tapered and non-tapered tubes and truncated cones of various dimensions, open-ended and closed-ended tubes, and bifurcated tubes. In embodiments employing a tapered pneumatic sock, the taper may be graduated from a larger distal end to a smaller proximal end to accommodate grasp or attachment to a user. It is advantageous for the pneumatic sock **108***a* to be sewn of a strong, lightweight, and abrasion resistant, flexible material such as fabric or mesh, but additional techniques such as fabric sealing, welding, gluing, or a combination thereof may be employed to make the pneumatic sock **108***a*. A slick material is advantageous to decrease friction during operation as well as to decrease the likelihood of causing skin abrasions to a user. Synthetic materials are typically stronger, lighter weight, and more abrasion resistant than natural fiber materials. Acrylic, aramid, nylon, olefin, polyester, rayon, and spandex are examples of flexible, synthetic materials that may be employed in the fabrication of the pneumatic sock **108***a*. For example, ripstop fabrics containing nylon or polyester fiber may be employed in an embodiment of the pneumatic sock **108***a* because these materials are easy to sew, strong, lightweight, abrasion resistant, resist tearing, and resist passage of air or airflow through the material. Ripstop fabrics resist tearing, and as a result, the likelihood of sudden failure (i.e. suddenly tearing apart) in an embodiment of the pneumatic sock **108***a* made with a ripstop fabric is decreased. For hygiene and infection control purposes, nylon and polyester fabrics are easily washed in laundry. Since the pneumatic sock **108***a* is removably coupled within the pneumatic conduit **102***a*, it can be removed to be washed, interchanged as a personal use item, or interchanged within a set of pneumatic socks in order to vary pneumatic resistance.

Pneumatic resistance may be varied by altering the amount of air passage or airflow through and around the pneumatic sock **108***a* and/or the material comprising the pneumatic sock **108***a* in an embodiment. The amount of air passage or airflow through the flexible material used in the fabrication of the pneumatic sock **108***a* is related to the weight, weave, thread count, thickness, ply, and other qualities of the material. For example, uncoated ripstop fabrics and many sport fabrics are typically permeable to air while providing substantial resistance to airflow to produce pneumatic resistance in an embodiment. As the pneumatic sock **108***a* shuttles within the pneumatic conduit **102***a*, the permeation of air through and/or around the pneumatic sock **108***a* is advantageous to provide pneumatic resistance as the pneumatic sock **108***a* moves in the airflow (as depicted in FIG. **1**C) during exercise. An open distal end or a hole in the material near a distal end, adjustable with a drawstring or similar means, may vary or adjust air passage in an embodiment. The pneumatic sock **108***a* or the material used to fabricate the pneumatic sock **108***a* may employ an air resistant coating or a patch of material with decreased permeability to air. For example, silicone, polyurethane, PTFE, or acrylic coatings may be employed to decrease or block the passage of air or airflow through the pneumatic sock **108***a* in an embodiment. Another means of decreasing the passage of air or airflow through the pneumatic sock **108***a* includes the addition of a lightweight fill material at the distal end and filling up to as much as one half of the portion of the pneumatic sock **108***a* within the pneumatic conduit. The lightweight material may be an aggregation of amorphous material, such as shredded foam, conformable to the shape of the pneumatic conduit **102***a* or a pneumatic conduit structure in an embodiment.

Depending on its dimensions and the particular material employed, the pneumatic sock **108***a* may weigh less than three ounces in an embodiment, which permits a user to increase speed of movement during exercise without a substantial change in resistance. In addition, the lightweight, tubular structure of the pneumatic sock **108***a* substantially diminishes any "whip effect" if the user inadvertently releases the pneumatic sock **108***a* during exercise, thereby increasing user safety. The diameter of the pneumatic sock **108***a* relates to the amount of resistance that may potentially be produced in a particular embodiment. Consequently, the pneumatic sock **108***a* may have a predetermined diameter, which may be less than or up to the inside diameter of the pneumatic conduit **102***a* (as depicted in FIG. **1**C), to target a potential range of resistance in an embodiment. Of course, as the diameter of the pneumatic sock **108***a* increases, the practicality of an embodiment tends to decrease due to increasing size and expense. For example, a diameter in the range of about 1 to 8 inches, with a preferred diameter range of about 1 to 4 inches, when inflated or filled is a practical size that may be fabricated at a reasonable expense in an embodiment of the pneumatic sock **108***a*. Due to the use of lightweight material such as nylon in an embodiment, the pneumatic sock **108***a* may be many feet in length but may weigh only a few ounces. For example, a length of about 4 to 18 feet, including a user interface, is a practical range for the length of the pneumatic sock **108***a* for most applications in a home or smaller facility in an embodiment. However, a length of about 4 to 12 inches may be appropriate for embodiments designed for hand exercises involving wrist and finger joints; about 12 to 48 inches may be appropriate for embodiments designed for extremity exercises involving wrist, elbow and shoulder joints; about 4 to 13 feet for embodiments designed for large movement exercises involving simultaneous movement of multiple joints of the user's body; and about 6 to 18 feet for embodiments designed to be used with an inflatable cushion or a housing comprising pneumatic conduits.

The pneumatic conduit **102***a* comprises hollow cylinders or tubes including pneumatic cylinders, pneumatic pipes, pneumatic tubes, pneumatic hoses, or pneumatic ducts, or combinations thereof, made of a rigid or a flexible material and may be linear or curved in configuration. A number of polymers may comprise the pneumatic conduit **102***a* including acrylic, acrylonitrile butadiene styrene, fluoropolymers (such as PTFE), nylon, polyester, polyethylene, polycarbonate, polypropylene, and polyvinyl chloride. In an embodiment, the pneumatic conduit **102***a* includes an inexpensive, lightweight polymer with a low coefficient of friction, such as polyethylene or polyvinyl chloride, to facilitate slidable movement of the pneumatic sock **108***a*. It is preferred that the wall of the pneumatic conduit **102***a* have a negative pressure rating up to about 14.7 lbs. per square inch in an embodiment. The wall of the pneumatic conduit **102***a* may be reinforced by various means, such as imbedded braid reinforcement, wire reinforcement, reinforcement with a stiffer polymer or other material, dual walls or a thick wall in an embodiment.

The amount of resistance that may potentially be produced by a particular embodiment increases as the diameter of the pneumatic conduit **102***a* increases. Consequently, the pneumatic conduit **102***a* may be of a predetermined diameter to achieve a targeted potential resistance or range of resistance in an embodiment. However, as the diameter of the pneumatic conduit **102***a* increases, the practicality of an embodiment tends to decrease due to increasing size and expense. For example, the pneumatic conduit **102***a* having an inside diameter range of about 1 to 8 inches, with a preferred inside diameter range of about 1 to 4 inches, is a practical size range that may be fabricated at a reasonable expense in an embodiment. The diameter of the primary opening **104***a* may approximate the diameter of the pneumatic conduit **102***a* but it is preferred that the diameter of the primary opening **104***a* is less than the diameter of the pneumatic conduit **102***a* in an embodiment. For example, the inside diameter of the primary opening **104***a* may be in a range from about 1 to 8 inches in an embodiment, with a preferred range of about 1 to 2⅜ inches inside diameter. The pneumatic conduit **102***a* may be employed in a wide range of lengths. For example, a range of about 3 to 12 feet is a practical range for the length of the pneumatic conduit **102***a* in an embodiment. A length of less than about 3 feet in an embodiment does not permit sufficient movement of the pneumatic sock **108***a* for most applications and a length of greater than about 12 feet would be an impractical size for use in most homes or smaller facilities. Further, the pneumatic sock in most embodiments will be longer (including the length of a user interface) than the length of the pneumatic conduit. However, a length of about 3 to 11 inches may be appropriate for embodiments designed for hand exercises involving wrist and finger joints; about 11 to 47 inches may be appropriate for embodiments designed for extremity exercises involving wrist, elbow and shoulder joints; about 3 to 12 feet for embodiments designed for large movement exercises involving simultaneous movement of multiple joints of the user's body; and about 5 to 12 feet for embodiments designed to be used with an inflatable cushion or a housing comprising pneumatic conduits, providing greater length to support a user and for stability.

FIG. **2**A depicts a perspective view of the pneumatic sock **108***a* made of a flexible material and having the proximal end **202** and the distal end **204** in an embodiment. The pneumatic sock **108***a* is easily configured to the user's extremities, such as a hand or a foot, in an embodiment. For example, the user may directly attach a hand or a foot to the pneumatic sock **108***a* by various means such as holding or wrapping the proximal end **202** in the palm of a hand. A handle, a loop, a cuff, or a pocket may also function as a user interface **203** in an embodiment. In an embodiment, the user interface **203** comprises at least one pocket with at least one opening that may be configured in different forms and manners for exercises in a variety of positions and planes of movement. FIG. **2**B depicts a perspective view of a bifurcated pneumatic sock **108***a* with a pair of tapered proximal ends **202***ba*, **202***bb* in an embodiment. The pair of tapered proximal ends **202***ba*, **202***bb* may facilitate bilateral grasp or attachment to a user in an embodiment.

FIG. **3**A depicts a partial perspective view of the pneumatic sock **108***a* with the proximal end **202** comprising the user interface **203** in an embodiment. The proximal end **202** may be grasped or wrapped in the palm of a hand by a user without the need for any additional elements or any particular configuration of the pneumatic sock **108***a*. However, in an embodiment, the user interface **203** may comprise a handle fashioned by tying or sewing a loop in the proximal end **202**. The proximal end **202** and/or the user interface **203** comprising a lightweight, resilient material such as neoprene, foam, gel, felt, batting material, or a soft fabric such as fleece or flannel fabric, or other such material, may increase user comfort and facilitate engagement of the pneumatic sock **108***a* by the user. The user interface **203** may comprise a handle wrapped around and fastened to the proximal end **202** of the pneumatic sock **108***a* with a hook & loop fastener, for example, in an embodiment. For hygiene purposes, the user interface **203** comprising a handle may be removable to permit washing and interchangeable as a personal use item in an embodiment.

FIG. **3**B depicts a partial perspective view of the user interface **203** comprising a handle and a cable **303**, rope, or cord in an embodiment. The cable **303**, rope, or cord may be tied or fastened to the pneumatic sock **108***a*, such as fastening to a grommet placed in the proximal end **202**, in an embodiment. A pulley system may be employed to support the cable **303**, rope, or cord to transmit pneumatic resistance from the pneumatic sock **108***a* to the user in an embodiment.

FIG. **4** depicts a perspective view of the pneumatic sock **108***a* with the distal end **204** and the proximal end **202** filled with lightweight material in an embodiment. The distal end **204** of the pneumatic sock **108***a* may comprise lightweight material, such as a resilient or plastic member or material, to enable directed airflow within the pneumatic conduit (as depicted in FIG. **1**C) to oppose the user and his/her movement of the pneumatic sock **108***a* in either direction (with or against airflow) during exercise. In addition, the pneumatic sock **108***a* may comprise lightweight material in the distal end **204** and/or the proximal end **202** to deter the pneumatic sock **108***a* from being pulled through the primary or secondary openings (as depicted in FIG. **1**C) by the user or by airflow during exercise. Lightweight material may comprise a single member, preferably with a circular cross-section such as a cylinder, a disc, a sphere, a cone, or a truncated cone, or lightweight material may comprise an aggregation or mass of lightweight material, such as shredded foam or polyester fiberfill, generally conforming to the shape of the distal end **204** of the pneumatic sock **108***a* in an embodiment. Lightweight material may be resilient, such as foam, or rigid, such as lightweight plastic. Lightweight material may be inserted or removed from the pneumatic sock **108***a* through an opening **706** in the proximal end **202** in an embodiment. The distal end **204** filled with lightweight material comprises a pressure opposing structure to enable airflow within the pneumatic conduit **102***a* to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise. The proximal end **202** of the pneumatic sock **108***a* may be configured to interface with the user's extremity by means of the user interface **203** comprising a mitt or a glove with the opening **706** for insertion of the user's hand or foot and/or lightweight material, in an embodiment. The proximal end **202** comprising a mitt may include lightweight, resilient material for user comfort, such as neoprene, gel, foam, felt, batting material, or a high-loft material such as polyester fleece or other such material in an embodiment.

FIG. **5***a* depicts a perspective view of a cylinder-shaped member **500***a* made of a lightweight material with a central hole **502** in an embodiment and FIG. **5***b* depicts a perspective view of a disc-shaped member **500***b* made of a lightweight material with the central hole **502** in an embodiment. The lightweight member **500***a*, **500***b* with the central hole **502** may include other shapes, preferably with a circular cross-section, conforming to the shape of the pneumatic conduit **102***a* or pneumatic conduit structure in an embodiment (as depicted in FIGS. **8** & **17**.) The outside diameter and/or the inside diameter of the cylinder-shaped member **500***a* with the central hole **502** and the disc-shaped member **500***b* with the central hole **502** may be varied to vary air passage or airflow through a pneumatic sock in an embodiment. In addition, the outside circumference and/or the inside circumference of the lightweight member **500***a*, **500***b* with the central hole **502** may be scalloped or made with grooves instead of made smooth as a means of varying airflow in an embodiment. Since the resistance to air movement or airflow through the central hole **502** increases as the diameter of the central hole **502** decreases, the central hole **502** may be configured as a feature of an interchangeable member **500***a*, **500***b* to vary air passage or airflow through a pneumatic sock in an embodiment

An embodiment was employed to illustrate how the member **500***a*, **500***b* with the central hole **502** (as depicted in FIGS. **5**A & **5**B) can be configured to vary airflow. The secondary opening **106***a* of a 4 inch schedule **40** polyvinyl chloride pipe comprising the pneumatic conduit **102***a* was interfaced with a hose attachment to a **1050**-watt vacuum cleaner, with 116 cubic feet per minute airflow rating, configured as an air evacuation source **920**. Using the formula V=Q/A, where V is the air velocity, Q is the airflow, and A is the cross-sectional area of the conduit **102***a*, the velocity of the airflow in this example is about 22 feet per second in the interior of the conduit **102***a*. Consequently, the velocity of the airflow is substantially greater than the velocity of typical exercise movements produced by a user, as the user moves the pneumatic sock **108***a* either towards or away from the conduit **102***a*. Plastic discs **500***b*, as depicted in FIG. **5**B, measuring 3⅞ inches in outside diameter were placed in the distal end **204** of an embodiment of the pneumatic sock **108***a* (as depicted in FIG. **7**) measuring about 4 inches in diameter in order of increasing diameter of the central hole **502**. Initially, the plastic disc **500***b* without the central hole **502** was placed in the distal end **204** of the pneumatic sock **108***a* and a hand-held scale measured about 23 lbs. of pneumatic resistance at the proximal end **202** when the air evacuation source **920** was activated. Then, the air evacuation source **920** was deactivated and the plastic disc **500***b* without the central hole **502** was interchanged with the disc **500***b* having a ⅜ inch diameter central hole **502**. When the vacuum source **920** was re-activated, the hand-held scale measured about 17½ lbs. of pneumatic resistance at the proximal end **202**. Repeating this procedure using the disc **500***b* with the central hole **502** of ⅝ inch diameter resulted in pneumatic resistance of about 15 lbs., using the disc **500***b* with the central hole **502** of ¾ inch diameter resulted in pneumatic resistance of about 12½ lbs., and using the disc **500***b* with the central hole **502** of 1 inch diameter resulted in pneumatic resistance of about 10 lbs. Consequently, it is apparent from the illustration above that the central hole **502** may be configured as a feature of an interchangeable member to vary airflow or air passage through the distal end **204** of the pneumatic sock **108***a* in an embodiment.

FIG. **6** depicts a perspective view of a cylinder-shaped member **500***a* made of a resilient, lightweight material in an embodiment. In the illustrated embodiment, the resilient, lightweight member **500***a* is cylinder-shaped but a resilient, lightweight member may include other shapes, preferably with a circular cross-section, such as a disc, a sphere, a cone, or a truncated cone, in order to conform to the pneumatic conduit or pneumatic conduit structure in an embodiment (as depicted in FIGS. **8** & **17**.) The resilient, lightweight member **500***a* may be made of an open-cell or a closed-cell foam material including ethylene vinyl acetate foam, polyethylene foam, polystyrene foam, polyurethane foam, latex foam, and other resilient materials such as felt or rubber. For example, the cylinder-shaped member **500***a* may be precisely cut from cross-linked polyethylene foam sheet, preferably about 4 inches thick, using an industrial water jet cutter in an embodiment. Resilient material will not damage or break equipment if a user releases a pneumatic sock during exercise, thereby serving as an impact-resistant bumper. The resilient member **500***a* may also serve as a sound dampening material in an embodiment. The resilient, cylinder-shaped member **500***a* made of foam in an embodiment may add less than one ounce to the weight of a pneumatic sock, thereby keeping acceleration forces low during operation, and may include the central hole (depicted in FIGS. **5**A & **5**B) as a feature to vary air passage or airflow in an embodiment.

FIG. **7** depicts a perspective view of the pneumatic sock **108***a* with the distal end **204** comprising the lightweight member **500***a* and having the opening **706** for insertion of material in an embodiment. The lightweight member **500***a* may augment the distal end **204** of the pneumatic sock **108***a* to resist the passage of air or airflow in an embodiment. The opening **706** permits the lightweight member **500***a* to be inserted or removed through a side of the pneumatic sock **108***a* in an embodiment. If the distal end **204** is filled with an aggregate of lightweight material that may spill out of the opening **706**, a closure such as stitches, a hook & loop fastener, a zipper, or a drawstring may be employed to close the opening **706** in an embodiment. The proximal end **202** of the pneumatic sock **108***a* may be configured to interface with the user's extremity by means of the user interface **203** comprising a handle shaped opening for insertion of the user's hand or foot, in an embodiment. The proximal end **202** and/or the user interface **203** comprising a handle shaped opening may include a lightweight, resilient material for user comfort, such as a neoprene, gel, foam, felt, batting material, or a soft fabric such as fleece or other such material in an embodiment.

FIG. **8** depicts a partial perspective view of a pneumatic sock exercise device in an embodiment illustrating the distal end **204** of the pneumatic sock **108***a* slidably coupled within the pneumatic conduit **102***a*. The secondary opening **106***a* is configured to be removably interfaced with an air evacuation source (as depicted in FIG. **9**A) in an embodiment. The distal end **204** of the pneumatic sock **108***a* shuttles within the pneumatic conduit **102***a* when the pneumatic sock **108***a* is moved by a user on a path towards and away from the conduit, whereby the pneumatic sock **108***a* enables airflow within the pneumatic conduit **102***a* to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise when the secondary opening **106***a* is interfaced with an air evacuation source in an embodiment. In addition, the pneumatic sock **108***a* may be removable through the secondary opening **106***a* by grasping the distal end **204** and sliding the pneumatic sock **108***a* from the interior of the pneumatic conduit **102***a* with an air evacuation source removed in an embodiment. The distal end **204** of the pneumatic sock **108***a* provides a pressure opposing structure to enable airflow within the pneumatic conduit **102***a* to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise.

FIG. **9**A depicts a perspective view of a pneumatic sock exercise device in an embodiment comprising the pneumatic conduit **102***a*, the primary opening **104***a*, the secondary opening **106***a* configured to be removably interfaced with an air evacuation source **920**, and the pneumatic sock **108***a*. The pneumatic sock **108***a* is slidably coupled within the pneumatic conduit **102***a* and extends through the primary opening **104***a*. (The pneumatic sock **108***a* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8**. & FIG. **17**) The pneumatic sock **108***a* may be coupled within the pneumatic conduit **102***a* by removing any fill material or additional members from the pneumatic sock **108***a* and placing the distal end into the primary opening **104***a*, followed by activation of the air evacuation source **920** interfaced with the secondary opening **106***a*. Airflow pulls the pneumatic sock **108***a* into the pneumatic conduit **102***a* through the primary opening **104***a* as the user maintains grasp on the proximal end of the pneumatic sock **108***a*. Then, the air evacuation source **920** may be deactivated and removed from the secondary opening **106***a* to access the distal end of the pneumatic sock **108***a* as depicted in FIG. **8**. As depicted in FIG. **7**, material may be placed in the distal end of the pneumatic sock **108***a* through the side opening **706**. Referring back to FIG. **9**A, the distal end of the pneumatic sock **108***a* may be pushed back inside the pneumatic conduit **102***a* through the secondary opening **106***a* after placement of material in the distal end. Exercise may begin when the air evacuation source **920** is subsequently interfaced and re-activated in an embodiment.

A cushion **912** comprising a resilient material, such as natural rubber, synthetic rubber, vulcanized fabric, plastic, foam, gel, or a combination thereof configured as an inflatable bolster to substantially enclose the exterior surface of the pneumatic conduit **102***a* may be included in an embodiment, thereby providing cushioning for a user and providing cushioning between the pneumatic conduit **102***a* and the floor. The cushion **912** may be inflatable with air through at least one opening including at least one air valve **914**, such as a hinged lid or a plug that opens and closes, in an embodiment. The cushion **912** may comprise at least one inflatable compartment, including at least one panel of resilient material and at least one seam **916** in an embodiment. Inflation of the cushion **912** with air provides a means of adapting the stability of a pneumatic sock exercise device in an embodiment. For example, it may be advantageous to adapt the stability of an embodiment to facilitate engagement of the user's core muscles during exercise. A source of airflow, such as the air evacuation source **920** adapted as a blower, may be used to inflate the cushion **912** in an embodiment.

Referring to FIG. **9**A, the secondary opening **106***a* may be configured with or comprise the connector (as depicted in FIG. **1**A), a fitting, a flange, a gasket, a seal, a hose, or a combination thereof to form an interface or connection between the pneumatic conduit **102***a* and the air evacuation source **920**. When interfaced or coupled with the air evacuation source **920**, air is removed from the pneumatic conduit **102***a* through the secondary opening **106***a* as additional air enters the pneumatic conduit **102***a* through the primary opening **104***a*. The air evacuation source **920** may include a vacuum pump or an exhaust fan in an embodiment. For example, a commercially available vacuum cleaner with a hose attachment may be adapted as the vacuum pump and employed as the air evacuation source **920** in an embodiment. The air evacuation source **920** comprising a variable motor speed control may be employed to vary pneumatic resistance by varying the airflow within the pneumatic conduit **102***a*.

During operation of the pneumatic sock exercise device depicted in FIG. **9**A, the pneumatic sock **108***a* is urged by and in the direction of airflow within the pneumatic conduit **102***a* when the secondary opening **106***a* of the pneumatic conduit structure **102***a* is interfaced with an air evacuation source **920** in an embodiment. The user is able to sit, step, stand, or recline on the pneumatic conduit **102***a*, thereby employing the user's body weight to anchor the embodiment to the floor. As the user moves the pneumatic sock **108***a* on a path towards and away from the primary opening **104***a* of the pneumatic conduit **102***a*, the pneumatic sock **108***a* shuttles along a path adjacent to the interior wall (the interior wall **1102***a* is depicted in FIG. **1**C & FIG. **11**) within the pneumatic conduit **102***a*. Airflow within the pneumatic conduit **102***a*, urging the pneumatic sock **108***a* in the direction of the airflow, transmits pneumatic resistance to the user as the user moves the pneumatic sock **108***a* on a path towards and away from the primary opening **104***a* of the pneumatic conduit **102***a*. The air evacuation source **920** may be configured with a variable control to vary airflow within the pneumatic conduit **102***a* as a means of varying resistance transmitted to the user. The means of varying resistance transmitted to the user during operation include varying the airflow within the pneumatic conduit **102***a*, varying the diameter of the pneumatic conduit **102***a*, varying the diameter of the primary **104***a* or the secondary opening **106***a*, varying the diameter of the pneumatic sock **108***a*, varying air passage or airflow around and/or through the pneumatic sock **108***a*, or a combination of these aspects.

FIG. **9**B depicts a perspective view of a pneumatic sock exercise device in an embodiment comprising a pair of pneumatic conduits **102***a*, **102***b*, a pair of primary openings **104***a*, **104***b*, a pair of secondary openings **106***a*, **106***b*, and a pair of pneumatic socks **108***a*, **108***b*. The pneumatic socks **108***a*, **108***b* are slidably coupled within the pneumatic conduits **102***a*, **102***b* and extend through the primary openings **104***a*, **104***b*. (The pneumatic socks **108***a*, **108***b* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8**. & FIG. **17**) The cushion **912** comprising a resilient material is configured as an inflatable pad to substantially enclose the exterior walls of the pneumatic conduits **102***a*, **102***b*, thereby providing cushioning for the user and providing cushioning for the pneumatic conduits **102***a*, **102***b* in an embodiment. The cushion **912** may include fasteners to hold the pneumatic conduits **102***a*, **102***b* in place, such as straps with hook & loop fasteners, in an embodiment.

Referring to the air evacuation source **920** in FIG. **9**A and the embodiment in FIG. **9**B, the secondary openings **106***a*, 106*b* may be configured with or comprise connectors (as depicted in FIG. 1A), fittings, flanges, gaskets, seals, or hoses, or a combination thereof to form an interface or connection between the pneumatic conduits **102***a*, **102***b* and the air evacuation source **920**. When interfaced or coupled with the air evacuation source **920**, air is removed from the pneumatic conduits **102***a*, **102***b* through the secondary openings **106***a*, **106***b* as additional air enters the pneumatic conduits **102***a*, **102***b* through the primary openings **104***a*, **104***b*. The air evacuation source **920** may include a vacuum pump or an exhaust fan and may comprise a plurality of sources in an embodiment. For example, a commercially available vacuum cleaner may be adapted as a vacuum pump and employed as the air evacuation source **920** with each of the two ends of a bifurcated hose serving as sources interfaced or coupled with the secondary openings **106***a*, **106***b* of the pneumatic conduits **102***a*, **102***b* in an embodiment. In another embodiment, the air evacuation source **920** may be comprised of two sources, such as two vacuum pumps, with each source interfaced with a pneumatic conduit **102***a*, **102***b*. The air evacuation source **920** may be employed to vary pneumatic resistance by varying the airflow within the pneumatic conduit **102***a*.

FIG. **10**A depicts a perspective view of a pneumatic sock exercise device in an embodiment comprising the pneumatic conduit **102***a* with the primary opening **104***a* and the secondary opening **106***a*, an extension means, which may include an extension tube **1010***a* operatively coupled to the primary opening **104***a* in the pneumatic conduit **102***a*, and a pneumatic sock **108***a*. The pneumatic sock **108***a* is slidably coupled within the pneumatic conduit **102***a* and extends through the primary opening **104***a* and the extension tube **1010***a*. (The pneumatic sock **108***a* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**.) The cushion **912** comprising a resilient material may be configured to substantially enclose the exterior wall (as depicted in FIG. **1**C) of the pneumatic conduit **102***a*, thereby providing cushioning for the user and providing cushioning for the pneumatic conduit **102***a* in an embodiment.

The extension tube **1010***a* may be pivotally or rotatably coupled to the primary opening **104***a*, thereby providing a range of substantially unrestricted movement to the pneumatic sock **108***a* extending through the primary opening **104***a* and the extension tube **1010***a* in an embodiment. For example, the primary opening **104***a* may be threaded or have a threaded fitting to allow a threaded end of the extension tube **1010***a* to be screwed or twisted into the primary opening **104***a* to form the rotatable coupling in an embodiment. The extension tube **1010***a* may have a shoulder or a flange to form a buttress for rotating or pivoting against a bushing or a bearing coupled to the primary opening **104***a* in an embodiment. An elastomeric element, such as a rubber sleeve or a rubber donut, may be used to create a flexible coupling to allow twist or limited rotation between the extension tube **1010***a* and the primary opening **104***a* in an embodiment. The primary opening **104***a* may have grooves to couple with an end of the extension tube **1010***a* having splines in an embodiment. A combination of the foregoing aspects and features may be employed to couple the extension tube **1010***a* to the primary opening **104***a* of the pneumatic conduit **102***a* in an embodiment.

The extension tube **1010***a* may be made of a strong, lightweight polymer having a low coefficient of friction, such as nylon, HDPE, or ultra-high molecular weight polyethylene (UHMW-PE), or other such polymers in an embodiment. The interior of the extension tube **1010***a* may include a low friction lining or coating, such as a polytetrafluoroethylene (PTFE) coating, in an embodiment. The extension tube **1010***a* may be straight and/or curved (including any portion of the circumference of a circle), or may comprise a combination of straight and/or curved segments, and may comprise a rigid or a resilient material in an embodiment. The extension tube **1010***a* may also have a flared (e.g., trumpet shaped) opening or a rounded flange at its terminal opening to facilitate movement of the pneumatic sock **108***a* as the pneumatic sock **108***a* extends through the extension tube **1010***a*. The diameter of the extension tube **1010***a* may approximate the diameter of the pneumatic conduit **102***a* but it is preferred that the diameter of the extension tube **1010***a* is less than the diameter of the pneumatic conduit **102***a*. For example, the inside diameter of the extension tube **1010***a* may range from about 1 to 8 inches in an embodiment, with a preferred range of about 1 to 2⅜ inches inside diameter. Extension means refers to a means of providing a range of substantially unrestricted movement to the pneumatic sock **108***a* extending through the primary opening **104***a* of the pneumatic conduit **102***a* such as the extension tube **1010***a* or an extension arm. Extension means and anti-friction means may also include a roller, a wheel, a pulley, a pulley system, a rolling-element bearing, a plain bearing, a flexure bearing, a fluid bearing, or an interior lining or coating with a low coefficient of friction or combinations thereof to extend a range of substantially unrestricted movement to the proximal end of the pneumatic sock **108***a* in an embodiment.

FIG. **10**B depicts a perspective view of a pneumatic sock exercise device in an embodiment comprising the pneumatic conduit **102***a*, the primary opening **104***a*, the secondary opening **106***a* configured to be removably interfaced with the air evacuation source **920**, the extension tube **1010***a* operatively coupled to the primary opening **104***a* in the pneumatic conduit **102***a*, and the pneumatic sock **108***a*. The pneumatic sock **108***a* is slidably coupled within the pneumatic conduit **102***a* and extends through the primary opening **104***a* and the extension tube **1010***a*. (The pneumatic sock **108***a* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**.) The secondary opening **106***a* may be configured with a flange, a gasket, a seal, a hose **1012***a*, or a combination thereof to form an interface or connection between the pneumatic conduit **102***a* and the air evacuation source **920**. The cushion **912** comprising a resilient material may be configured to substantially enclose the exterior walls (as depicted in FIG. **1**C) of the pneumatic conduit **102***a*, thereby providing cushioning for the user and providing cushioning for the pneumatic conduit **102***a* in an embodiment.

FIG. **11** depicts a partial perspective view of a pneumatic sock exercise device in an embodiment with the pneumatic sock **108***a* slidably coupled within the pneumatic conduit **102***a* having interior and exterior walls **1102***a*, **1104***a* and further including an extension arm **1110***a* and a pulley **1112***a* operatively mounted in a position adjacent to the primary opening **104***a*. The pneumatic sock **108***a* shuttles along a path adjacent to the interior wall **1102***a* within the pneumatic conduit **102***a* when the pneumatic sock **108***a* is moved by a user on a path toward and away from the conduit. The pneumatic sock **108***a* is able to bear upon the pulley **1112***a* when the pneumatic sock **108***a* is engaged by a user, with the extension arm **1110***a* extending the range of movement of the pneumatic sock **108***a* away from the primary opening **104***a* in an embodiment. The extension arm **1110***a* may be pivotally or rotatably mounted to either the pneumatic conduit **102***a* or a housing or frame in a position adjacent to the primary opening **104***a* in an embodiment. In addition, the extension arm **1110***a* may be straight and/or curved or may comprise a combination of straight and/or curved segments in an embodiment. The extension arm **1110***a* may be configured with the pulley **1112***a*, a pulley system, a roller, a wheel, a rolling-element bearing, a plain bearing, a flexure bearing, a fluid bearing, or a lining or coating with a low coefficient of friction or a combination thereof to extend the range of movement of the pneumatic sock **108***a* away from the primary opening **104***a* in an embodiment.

FIG. **12**A depicts a perspective view of a pneumatic sock exercise device in an embodiment comprising the pneumatic conduit **102***a*, the primary opening **104***a* operatively coupled to the extension tube **1010***a*, a housing **1202** comprising the secondary opening **106***a* configured to be removably interfaced with the air evacuation source **920**, and the pneumatic sock **108***a* extending through the extension tube **1010***a*. The pneumatic sock **108***a* is slidably coupled within the pneumatic conduit **102***a* and extends through the primary opening **104***a* and the extension tube **1010***a*. (The pneumatic sock **108***a* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**.) The housing **1202** may comprise a frame configured with a flange, gasket, seal, or a combination thereof to removably interface the pneumatic conduit **102***a* and the air evacuation source **920**. When interfaced or coupled with the air evacuation source **920**, air is removed from the pneumatic conduit **102***a* through the secondary opening **106***a* and air enters the pneumatic conduit **102***a* through the extension tube **1010***a* and the primary opening **104***a*. The air evacuation source **920** may include a vacuum pump or an exhaust fan in an embodiment.

FIG. **12**B depicts a perspective view of a pneumatic sock exercise device interfaced with the air evacuation source **920** in an embodiment comprising the pneumatic conduit **102***a*, the primary opening **104***a* operatively coupled to the extension tube **1010***a*, the housing **1202** comprising the secondary opening interfaced with the air evacuation source **920**, and the pneumatic sock **108***a* extending through the extension tube **1010***a*. The pneumatic sock **108***a* is slidably coupled within the pneumatic conduit **102***a* and extends through the primary opening **104***a* and the extension tube **1010***a*. (The pneumatic sock **108***a* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**.) The housing **902** may comprise a frame configured with a flange, gasket, seal, or a combination thereof to removably interface the pneumatic conduit **102***a* and the air evacuation source **920**.

During operation of a pneumatic sock exercise device as depicted in FIGS. **12**A & **12**B, the pneumatic sock **108***a* is urged by and in the direction of airflow within the pneumatic conduit **102***a* when the secondary opening **106***a* of the pneumatic conduit structure **102***a* is interfaced with an air evacuation source **920** in an embodiment. As the user moves the pneumatic sock **108***a* on a path towards and away from the primary opening **104***a* of the pneumatic conduit **102***a*, the pneumatic sock **108***a* shuttles along a path adjacent to the interior wall (the interior wall **1102***a* is depicted in FIG. **11**) within the pneumatic conduit **102***a*. Airflow within the pneumatic conduit **102***a*, urging the pneumatic sock **108***a* in the direction of airflow, transmits pneumatic resistance to the user as the user moves the pneumatic sock **108***a* on a path towards and away from the primary opening **104***a* of the pneumatic conduit **102***a*. The air evacuation source **920** may be configured with a variable control to vary airflow within the pneumatic conduit **102***a* as a means of varying resistance transmitted to the user. The means of varying resistance transmitted to the user during operation of a pneumatic sock exercise device includes varying the airflow within the pneumatic conduit **102***a*, varying the diameter of the pneumatic conduit **102***a*, varying the diameter of the primary **104***a* or the secondary opening **106***a*, varying the diameter of the pneumatic sock **108***a*, varying air passage around and/or through the pneumatic sock **108***a*, or a combination of these aspects.

FIG. **13** depicts a perspective view of a pneumatic sock exercise device comprising a housing and pneumatic conduit structure **1202** having a pair of primary openings **104***a*, **104***b*, a secondary opening **106***a*, and a pair of pneumatic socks **108***a*, **108***b* in an embodiment. The pneumatic socks **108***a*, **108***b* are slidably coupled within the housing and pneumatic conduit structure **1202** and extend through the primary openings **104***a*, **104***b*. (The pneumatic socks **108***a*, **108***b* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**.) The primary openings **104***a*, **104***b* may be configured with rounded flanges (as depicted in FIG. **1**A) or a flared (e.g., trumpet shaped) openings. The primary openings **104***a*, **104***b* may also include a roller, wheel, pulley, pulley system, rolling-element bearing, plain bearing, flexure bearing, fluid bearing, or an interior lining or coating with a low coefficient of friction or combinations thereof to provide a range of substantially unrestricted movement to the proximal end of the pneumatic socks **108***a*, **108***b* in an embodiment. The cushion **912** comprising a resilient material, such as natural rubber, synthetic rubber, vulcanized fabric, plastic, neoprene, foam, gel, or a combination thereof, configured to the exterior of the housing and pneumatic conduit structure **902** may be included to cushion the user in an embodiment. The cushion **912** may be inflatable with air in an embodiment. The housing and pneumatic conduit structure **1202** may comprise a seat with a back support **1312** in an embodiment.

The housing and pneumatic conduit structure **1202** comprises both housing or frame and pneumatic conduit(s) **102***a* in one structure. It is advantageous for the housing and pneumatic conduit structure **1202** to be of a lightweight and portable construction and to be capable of supporting a user to employ the user's body weight to anchor an embodiment to the floor. The housing and pneumatic conduit structure **1202** comprises pneumatic conduits by utilizing contemporary manufacturing techniques with polymer materials. There are a number of strong, lightweight polymers that may be used in the fabrication of the housing and pneumatic conduit structure **1202** including acrylonitrile butadiene styrene (ABS), acrylic, nylon, polyester, polyethylene, polycarbonate, polypropylene, and polyvinyl chloride using a variety of different manufacturing methods.

One of the most economical methods for fabricating an embodiment of the housing and pneumatic conduit structure **1202** as depicted in FIG. **13** is by rotational molding, although other techniques for polymer fabrication (e.g. injection molding) may be employed. The most commonly used family of polymers in rotational molding is polyethylene, which includes cross linked polyethylene (XLPE), low-density polyethylene (LDPE), linear medium-density polyethylene (LMDPE), high-density polyethylene (HDPE), and ultra-high molecular weight polyethylene (UHMW-PE). Polyethylene is also easily cut, drilled, heat formed, shaped, and welded with a plastic welder. In addition to the ease of manufacturing with polyethylene, it has other properties that make it advantageous for the fabrication of the housing and pneumatic conduit structure **902**. For example, HDPE is lightweight, strong, easy to machine, and inexpensive, which are advantageous characteristics for the housing and pneumatic conduit structure **902** in an embodiment.

FIG. **14** depicts an exploded perspective view of the housing and pneumatic conduit structure **1202** in an embodiment.

An upper portion **1406**, a lower portion **1402**, and a front portion **1404** are illustrated which may be apparent during manufacture. An embodiment of the housing and pneumatic conduit structure **1202** may include the upper portion **1406** and the lower portion **1402** fastened or welded together with the front portion **1404** coupled to the joined portions as a removable structure or the housing and pneumatic conduit structure **1202** may include the upper portion **1406**, the lower portion **1402**, and the front portion **1404** fastened or welded together. The front portion **1404** may be rounded or may include a rounded flange in an embodiment. The housing and pneumatic conduit structure **1202** may have a plurality of structural support ribs **1408***a*, **1408***b*, **1408***c*, **1408***d*. A predetermined number, size, and configuration of structural support ribs **1408***a*, **1408***b*, **1408***c*, **1408***d* strengthen the housing and pneumatic conduit structure **1202** and structural support ribs may be configured in the lower portion **1402**, the upper portion **1406** or both portions in an embodiment.

FIG. **15** depicts a perspective view of the housing and pneumatic conduit structure **1202** with the front portion removed in an embodiment. The upper portion **1406** and the lower portion **1402** are illustrated with a joint **1502**, which may be inconspicuous after finishing, depending on the method of manufacture. Fastening or welding the upper portion **1406** and the lower portion **1402** of the housing and pneumatic conduit structure **1202** forms the pneumatic conduit structures in the interior. In order for the joint **1502** to be substantially airtight, a gasket or a seal may be placed between the upper portion **1406** and the lower portion **1402** prior to fastening or welding the portions together.

FIG. **16** depicts an exploded perspective view of the housing and pneumatic conduit structure **1202** with the front portion removed and additional pneumatic conduits **102***a*, **102***b* in an embodiment. The fabrication of the housing and pneumatic conduit structure **1202** may include the upper portion **1406**, the lower portion **1402**, and additional pneumatic conduits **102***a*, **102***b* joined together during manufacture in an embodiment. Additional pneumatic conduits **102***a*, **102***b* may be added to either the upper portion **1406** or the lower portion **1402** as finished pieces, prior to the joining of the portions in an embodiment.

FIG. **17** depicts an exploded perspective view of a pneumatic sock exercise device in an embodiment with the front portion removed and a pair of pneumatic socks **108***a*, **108***b* slidably coupled therein, with arrows to indicate direction of airflow during operation. The distal ends **204***a*, **204***b* of the pneumatic socks **108***a*, **108***b* are capable of slidable movement along a path adjacent to the interior walls **1102***a*, **1102***b* of the pneumatic conduit structure **1202** when the proximal ends **202***a*, **202***b* of the pneumatic socks **108***a*, **108***b* are moved by a user on a path towards and away from the pneumatic conduit structure **1202**, whereby the pneumatic socks **108***a*, **108***b* enable airflow within the pneumatic conduit structure **1202** to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise.

As indicated by the arrows in FIG. **17**, the distal ends **204***a*, **204***b* of the pneumatic socks **108***a*, **108***b* are urged by and in the direction of airflow when the pneumatic conduit structure **1202** having interior walls **1102***a*, **1102***b* and exterior walls **1104***a*, **1104***b* is interfaced with the air evacuation source **920** (as depicted in FIG. **18**) in an embodiment. As the user moves the proximal ends **202***a*, **202***b* of the pneumatic socks **108***a*, **108***b* on a path towards and away from the pneumatic conduit structure **1202**, the distal ends **204***a*, **204***b* of the pneumatic socks shuttle along a path adjacent to the interior walls **1102***a*, **1102***b* within the pneumatic conduit structure **1202**. Airflow around and through the distal ends **204***a*, **204***b* of the pneumatic socks **108***a*, **108***b*, merging in a unified portion **1702** of the pneumatic conduit structure **1202**, exits through the secondary opening **106***a*. Airflow within the pneumatic conduit structure **1202**, urging the distal ends **204***a*, **204***b* of the pneumatic socks **108***a*, **108***b*, in the direction of airflow, transmits pneumatic resistance to the user as the user moves the proximal ends **202***a*, **202***b* on a path towards and away from the pneumatic conduit structure **1202**. The proximal ends **202***a*, **202***b* of the pneumatic socks **108***a*, **108***b* comprise user interfaces and the distal ends **204***a*, **204***b* of the pneumatic socks **108***a*, **108***b* comprise pressure opposing structures to enable air within the pneumatic conduit structure **1202** to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise.

FIG. **18** depicts a perspective view of the pneumatic sock exercise device in an embodiment comprising the housing and pneumatic conduit structure **1202**, the primary openings **104***a*, **104***b*, the secondary opening **106***a* configured to be removably interfaced with the air evacuation source **920**, and the pneumatic socks **108***a*, **108***b*. The pneumatic socks **108***a*, **108***b* are slidably coupled within the housing and pneumatic conduit structure **1202** and extend through the primary openings **104***a*, **104***b*. (The pneumatic socks **108***a*, **108***b* may include aspects and features of embodiments described in this written description and depicted in FIG. **2**A through FIG. **8** & FIG. **17**) The housing and pneumatic conduit structure **1202** may be configured with the secondary opening **106***a* having a flange, gasket, seal or a combination thereof to removably interface the housing and pneumatic conduit structure **1202** and the air evacuation source **920**. Fasteners, such as clasps or buckles, may be used to hold the air evacuation source **920** in place when interfaced with the secondary opening **106***a* of the housing and pneumatic conduit structure **1202** in an embodiment. When interfacing with the air evacuation source **920**, air is removed from the housing and pneumatic conduit structure **1202** through the secondary opening **106***a* and air enters through the primary openings **104***a*, **104***b*. The air evacuation source **920** may include a vacuum pump or an exhaust fan. For example, a commercially available utility or wet/dry vacuum with tank removed may be adapted as the vacuum pump and employed as the air evacuation source **920** removably interfacing or coupling with the pneumatic sock exercise device in an embodiment.

During operation of an embodiment of a pneumatic sock exercise device as depicted in FIG. **18**, the pneumatic socks **108***a*, **108***b* are urged by and in the direction of airflow within the housing and pneumatic conduit structure **1202** when the secondary opening **106***a* is interfaced with an air evacuation source **920** in an embodiment. As the user moves the pneumatic socks **108***a*, **108***b* on a path towards and away from the primary openings **104***a*, **104***b* of the pneumatic conduit structure **1202**, the pneumatic socks **108***a*, **108***b* shuttle along a path adjacent to the interior walls (the interior walls **1102***a*, **1102***b* are depicted in FIG. **17**) within the pneumatic conduit structure **1202**. Airflow within the pneumatic conduit structure **1202**, urging the pneumatic socks **108***a*, **108***b*, in the direction of airflow, transmits pneumatic resistance to the user as the user moves the pneumatic socks **108***a*, **108***b* on a path towards and away from the primary openings **104***a*, **104***b* of the pneumatic conduit structure **1202**. The air evacuation source **920** may be configured with a variable control to vary airflow within the housing and pneumatic conduit structure **1202** as a means of varying resistance transmitted to the user. The means of varying resistance transmitted to the user during operation of the pneumatic sock exercise device include varying the airflow within the housing and pneumatic conduit structure **1202**, varying the diameter of the pneumatic conduit structure **1202**, varying the diameter of the primary **104***a*, **104***b* or the secondary opening **106***a*, varying the diameter of the pneumatic socks **108***a*, **108***b*, varying air passage or airflow around and/or through the pneumatic socks **108***a*, **108***b*, or a combination of these aspects.

In conclusion, embodiments of the pneumatic sock exercise device comprise the benefits of pneumatic resistance in a device that is lightweight, compact, and affordable for the typical exercise consumer at home or at a smaller facility. Complicated moving parts and imposing frames that are typical of traditional design are replaced with a less complicated and more contemporary design comprising various embodiments of the pneumatic sock exercise device. Consequently, it is anticipated that various embodiments of the pneumatic sock exercise device will facilitate greater exercise participation by the typical exercise consumer.

Although the pneumatic sock exercise device has been described in the context of various aspects, features and embodiments, it will be apparent to those skilled in the art that the pneumatic sock exercise device encompasses alternate embodiments, ramifications, and/or uses beyond the specifically disclosed embodiments. For example, the pneumatic sock exercise device may include alternate embodiments with housing or frame elements that have not been specifically disclosed. An alternate embodiment of a pneumatic sock exercise device may be attached to a separate housing or frame instead of, or in addition to, an integrated housing or frame structure. The pneumatic sock exercise device may include alternate embodiments with elements or components in a different orientation from those illustrated (e.g., vertically oriented pneumatic conduits instead of horizontal.) Alternate embodiments may also include any number of pneumatic socks and/or pneumatic conduits in a specific embodiment. For example, an alternate embodiment of a pneumatic sock exercise device may include four pneumatic socks and four pneumatic conduits in an embodiment for a user to engage all four extremities during exercise. The pneumatic sock exercise device may include pneumatic conduits with non-circular cross sections, such as rectangular or oval cross-sections, and pneumatic socks conforming to the shape of non-circular pneumatic conduits in an alternate embodiment. Alternate embodiments may be adapted or used for any suitable exercise or method of exercise as would be contemplated by one skilled therein. Alternate embodiments may be adapted for uses or operated in manners that have not been specifically disclosed (e.g., the physical simulation of rowing.) It is also contemplated that various combinations or substitution of equivalents of the disclosed aspects, features, and embodiments may be made within the scope of the pneumatic sock exercise device. Thus, it is intended that the scope of the pneumatic sock exercise device herein disclosed should not be limited by the particular disclosed embodiments described above for the purpose of fulfilling statutory requirements, but should be determined by a fair reading of the claims that follow.

I claim:

1. A pneumatic sock exercise device for use by a user, comprising:

a pneumatic conduit having interior and exterior walls and a primary opening permitting inflow of air and a secondary opening permitting outflow of air, configured to be removably interfaced with a source of airflow;

a pneumatic sock comprising a tubular structure made of a flexible material and having a proximal end and a distal end,

the distal end of the pneumatic sock is filled with a lightweight material and is slidably engaged within the pneumatic conduit and

the proximal end of the pneumatic sock is partially positioned in the pneumatic conduit and extends through outside of the pneumatic conduit from, and is slidably engaged with, the primary opening of the conduit and comprises a user interface, the user interface being wholly outside of the pneumatic conduit,

such that the distal end of the pneumatic sock shuttles along a path adjacent to the interior wall of the pneumatic conduit when the proximal end of the pneumatic sock is moved by a user at the user interface on a path towards and away from the primary opening of the pneumatic conduit,

whereby the pneumatic sock is designed and configured to enable directed airflow within the pneumatic conduit to oppose the user and his/her movement of the sock in either direction (with or against airflow) during exercise.

2. The pneumatic sock exercise device of claim **1** wherein the pneumatic conduit comprises a hollow cylinder.

3. The pneumatic sock exercise device of claim **1** further comprising a cushion comprising a resilient material configured to substantially enclose the exterior wall of the pneumatic conduit.

4. The pneumatic sock exercise device of claim **1** wherein the primary opening comprises a rounded flange.

5. The pneumatic sock exercise device of claim **1** wherein the primary opening further comprises a bushing comprising a rounded flange.

6. The pneumatic sock exercise device of claim **1** further comprising an extension tube operably coupled with the primary opening of the pneumatic conduit.

7. The pneumatic sock exercise device of claim **1** further comprising an extension arm operably mounted to the pneumatic conduit in a position adjacent to the primary opening.

8. The pneumatic sock exercise device of claim **1** wherein the secondary opening further comprises a connector configured to be removably interfaced with a source of airflow.

9. The pneumatic sock exercise device of claim **1** wherein the lightweight material is selected from the group consisting of foam and fiberfill.

10. The pneumatic sock exercise device of claim **1** wherein the lightweight material comprises a resilient or rigid member.

11. The pneumatic sock exercise device of claim **10** wherein the resilient or rigid member comprises a central hole.

12. The pneumatic sock exercise device of claim **10** wherein the resilient or rigid member comprises a cylinder-shaped member.

13. The pneumatic sock exercise device of claim **1** wherein the user interface comprises an end of the proximal end of the pneumatic sock.

14. The pneumatic sock exercise device of claim **1** wherein the pneumatic sock is bifurcated.

15. The pneumatic sock exercise device of claim **1** wherein the pneumatic sock is further configured with an opening for insertion of material.

16. A pneumatic sock exercise device for use by a user, comprising:

a pneumatic conduit having interior and exterior walls and a primary opening permitting inflow of air and a secondary opening permitting outflow of air, configured to be removably interfaced with a source of airflow, wherein at least a portion of the exterior walls of the pneumatic conduit comprises a flexible material;

a pneumatic sock comprising a tubular structure made of a flexible material and having a proximal end and a distal end,

the distal end of the pneumatic sock is slidably engaged within the pneumatic conduit and

the proximal end of the pneumatic sock is partially positioned in the pneumatic conduit and extends outside of the pneumatic conduit from, and is slidably engaged with, the primary opening of the conduit, and comprises a user interface, the user interface being wholly outside of the pneumatic conduit

such that the distal end of the pneumatic sock shuttles along a path adjacent to the interior wall of the pneumatic conduit when the proximal end of the pneumatic sock is moved by a user on a path towards and away from the primary opening of the pneumatic conduit,

whereby the pneumatic sock is designed and configured to enable directed airflow within the pneumatic conduit to oppose the user and his/her movement of the sock at the user interface in either direction (with or against airflow) during exercise.

17. The pneumatic sock exercise device of claim **16** wherein the flexible material is a cushion inflatable with air.

18. A pneumatic sock exercise device for use by a user, comprising:

a housing; a pneumatic conduit positioned within the housing, having interior and exterior walls and at least one primary opening permitting inflow of air and at least one secondary opening permitting outflow of air, configured to be removably interfaced with a source of airflow;

at least one pneumatic sock comprising a tubular structure made of a flexible material and having a proximal end and a distal end,

wherein the distal end of the pneumatic sock is slidably coupled within the pneumatic conduit and

the proximal end of the pneumatic sock is partially positioned in the pneumatic conduit and extends outside of the pneumatic conduit and is slidably engaged with the primary opening of the pneumatic conduit, and comprises at its end a user interface, the user interface being wholly outside of the pneumatic conduit,

such that the distal end of the pneumatic sock shuttles along a path adjacent to the interior walls of the pneumatic conduit when the proximal end of the pneumatic sock is moved by a user on a path towards and away from the primary opening of the pneumatic conduit,

whereby the pneumatic sock is designed and configured to enable directed airflow within the pneumatic conduit to oppose the user and his/her movement of the sock at the user interface in either direction (with or against airflow) during exercise.

19. The pneumatic sock exercise device of claim **18** wherein the housing comprises a rounded front portion supporting the primary opening.

20. The pneumatic sock exercise device of claim **18** wherein the housing comprises a molded polymer.

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